MARCH 1959

Power Engineering

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B&W Pulverizer Design Simplicity Cuts Maintenance

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Exceptional output and efficiency records . . . highlighted by low maintenance . . . have been established in hundreds of installations by B&W Pulverizers. Their long-range dependability has been accompanied by reduced operating costs.

Simplicity of Arrangement and Reduced Maintenance: Accessibility for all normal maintenance makes it simple, quick, safe, and low-cost. Adjustments are easily made while the unit is in operation. Using only clean primary air supplied under pressure, fan maintenance is substantially reduced and fuel piping is greatly simplified. Also, with the pulverizer acting as its own distributor, no special distributing devices are needed. Grinding elements are of special alloy material. They last two years or more on eastern coals and at least a year on midwestern coals.

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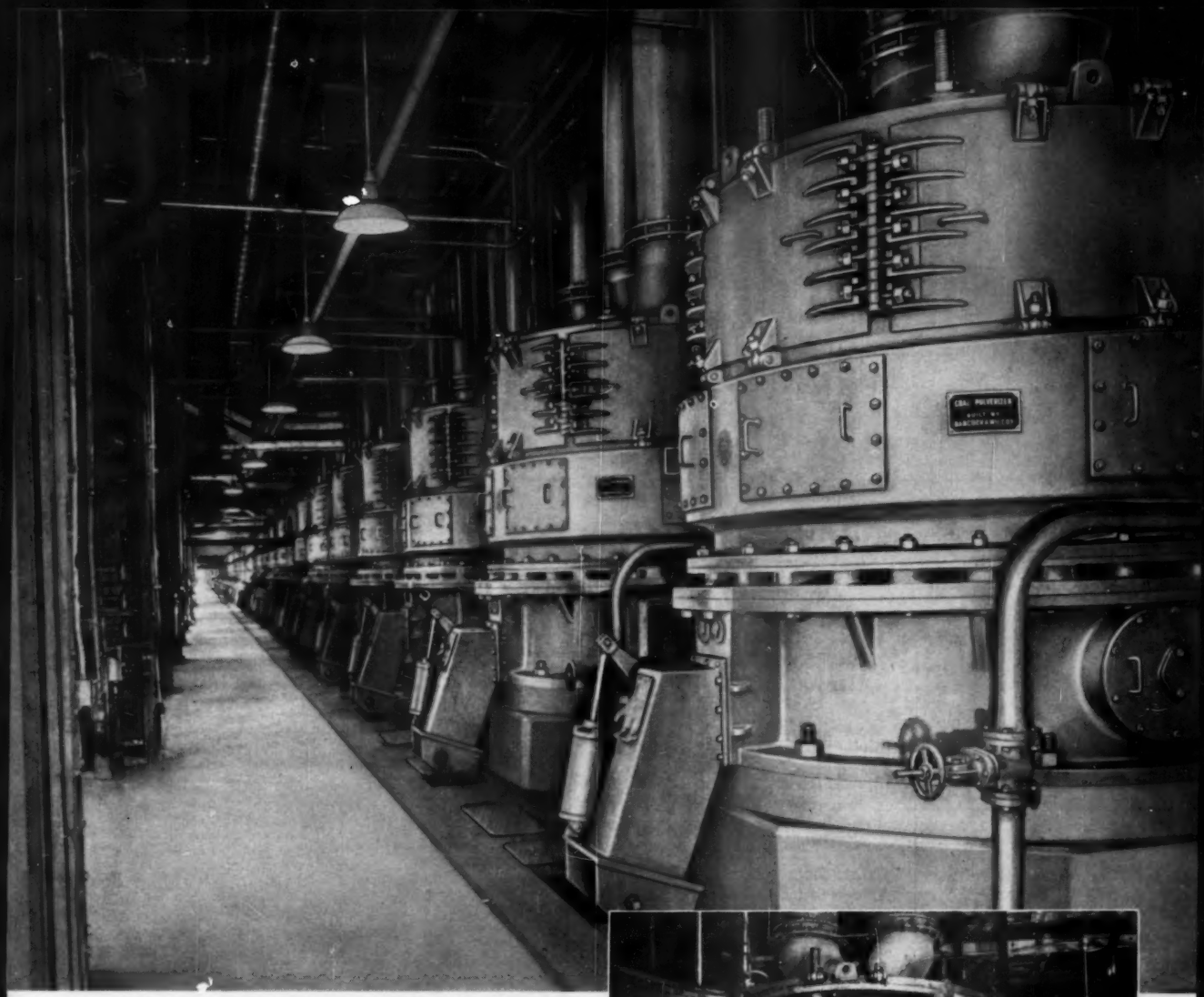
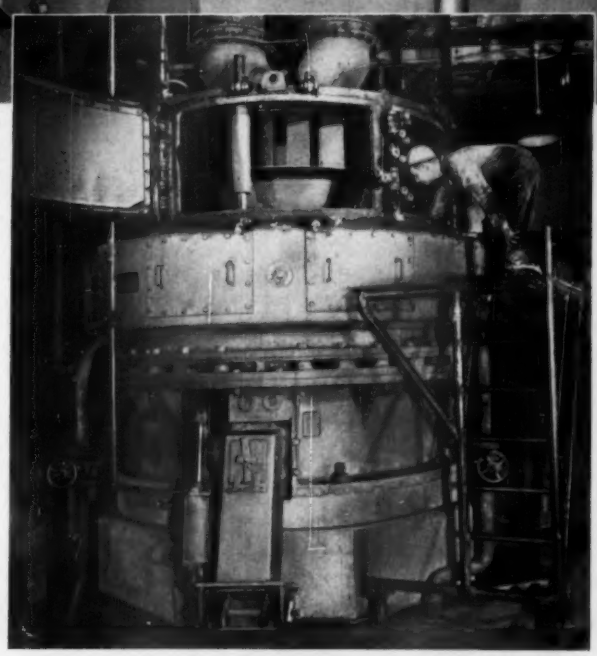
Adaptable to All Types of Automatic Controls: Because it features "one point contact with the





(Above) Part of the 42 B&W Pulverizers serving six B&W Open-Pass Boilers. (Right) Maintenance is simple: doors open wide, classifier and spring assemblies are readily accessible for removal. Grinding components are lifted without special rigging.

boiler," operation of the B&W Pulverizer is simple. The boiler's automatic combustion control is connected to the pulverizer at only one point—the damper in the primary-air duct. The pulverizer's own control system regulates all other functions, such as maintenance of proper fuel-air ratio and operating temperature.

SEND FOR DATA. For full information about the B&W Pulverizer and Pulverized-Fuel Firing Systems, write: The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W

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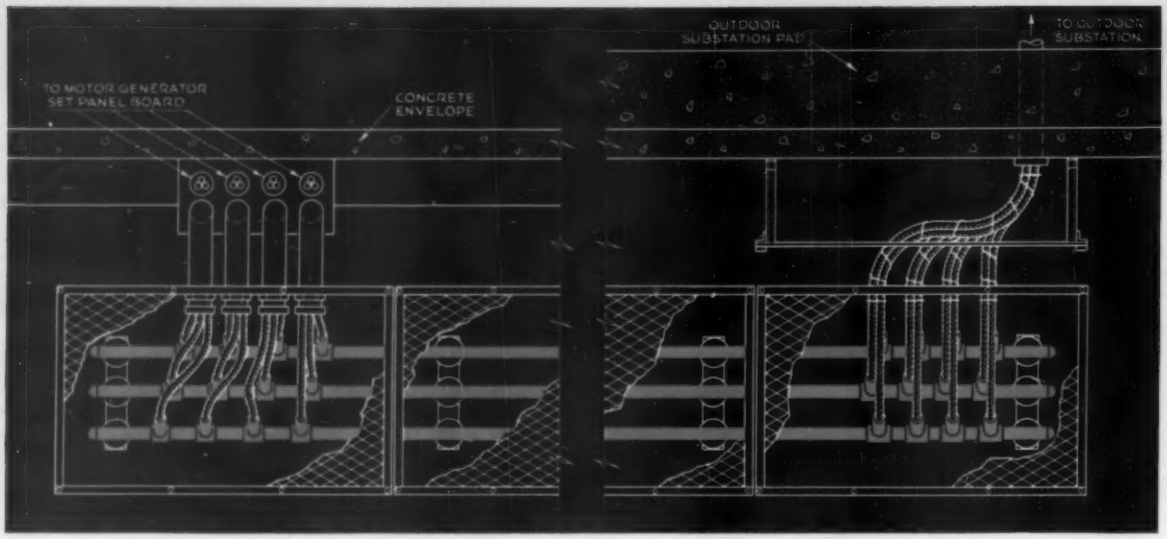


Side elevation of secondary bus system, using round tubular copper bus conductors, 2½" S.P.S., in unused plant tunnel. The run is approximately 275 feet long.

Round copper tube bus carries more amperes per pound of copper—cuts installation costs

When a large eastern electrolytic refinery recently shifted to purchased electric power, it capitalized on the electrical and mechanical advantages of round tubular copper bus conductors to effect some economies.

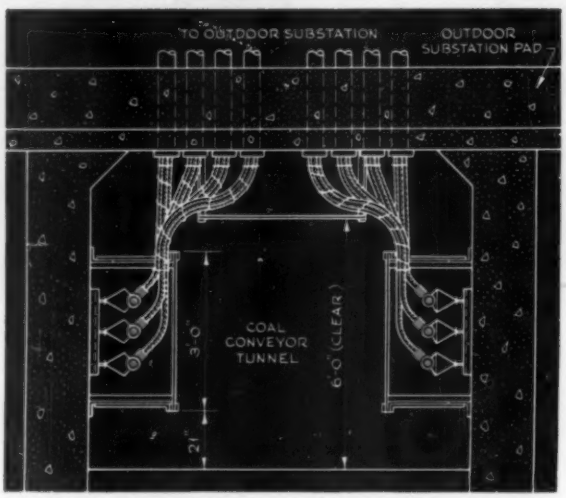
Directly below the 10,000 kv-a outdoor substation was an unused coal conveyor tunnel that ran some 275 feet back to the former powerhouse. In this, the secondary bus system using 2.3-kv high-conductivity bus tube, 2½" S.P.S., was installed as shown in the drawings.

These round conductors, having an extremely low skin-effect ratio (1.01) can carry well over 300 amperes per pound of copper—compared with less than 275 amperes per pound for rectangular bus of the same cross-sectional area.

In addition to this material saving, round conductors in standard pipe sizes made possible installation savings through the use of stock-size supports, connectors, and other hardware.

Substantial savings are often possible through the use of a tubular bus with a low wall-thickness-to-diameter ratio. More complete information on tubular conductors is available in the Sixth Edition of The American Brass Company's Publication C-25. This 62-page booklet has a wealth of general information on the properties of copper conductors—plus convenient data for the most commonly used sizes of all types of rigid bus conductors.

TECHNICAL SERVICES. Anaconda specialists are available to help you in the solution of technical problems involving the use of Anaconda Bus Conductors. For such service, or for a copy of Publication C-25, see your nearby Anaconda representative. Or write: The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass, Ltd., New Toronto, Ontario. 5069



End elevation of tunnel showing how bus conductors are mounted on either wall, covered by a simple expanded metal enclosure.

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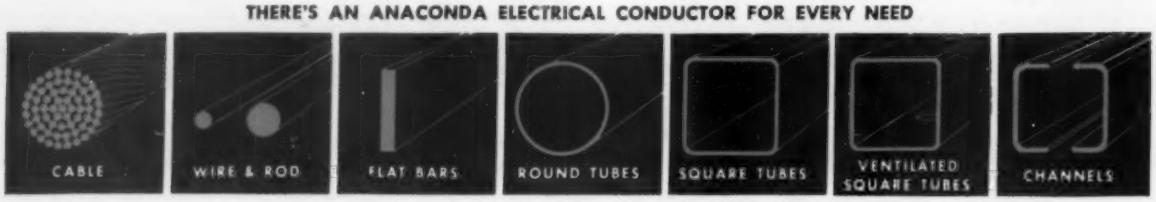

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ENGINEERS' PREVIEW

DEVICE known as the "plasma-jet," which started life within the last two years as a research tool for generating extremely high temperatures, is now being adapted to production uses. The equipment was originally intended to simulate heat conditions similar to those encountered at speeds many times the speed of sound. It is capable of developing temperatures up to 30,000 F.

Now the high temperature is being used to melt and apply metals and compounds with extremely high melting points. Tungsten, tantalum, columbium, and other refractory metals as well as their oxides, carbides and compounds can be used to build shapes on mandrels or to coat surfaces of other materials.

The jet is actually ultra-hot air which is shot from the unit by streams of high velocity inert gases which have passed through an electric arc. Metals to be deposited on a surface are injected as powders into the gas stream or fed in the form of wire into the jet. In addition to producing parts capable of withstanding high temperatures, the process is expected to be used for making electronic parts and special chemical process assemblies from materials that might not otherwise be formable.

In reviewing what metallurgy accomplished in 1958, Clarence H. Lorig, president of the American Society for Metals and technical director of Battelle Memorial Institute, also reports two new steels. One is an air cooling ultra-high strength alloy steel available in sheet form which develops tensile strengths up to 280,000 lb per sq in. upon air cooling. The steel is reputed to have good formability and to be readily welded.

The second steel is only a few steps removed from the research laboratory and has shown tensile strengths of more than 400,000 lb per sq. in. — a level never before reached with any metal. If the same strength levels can be matched in production quantities, the new steel will compete favorably with titanium alloys on a strength-to-weight basis. The steel is reported to have high ductility as compared to similar compositions of steel which are notoriously brittle. The steel retains its ductility down to −385F.

NATIONAL INSULATION Manufacturers Association has been formed by members of the industrial insulation industry at a recent meeting held in New York City. President of the new organization is E. H. Luchs of the Mundet Cork Corporation. R. A. McLaughlin, Pittsburgh Plate Glass Co is vice president; F. T. Christenson, Refractory and Insulation Corp, is treasurer, and J. M. Barnhart is executive secretary. Offices are at 441 Lexington Ave, New York 17, N. Y.

THINK there's an engineering manpower shortage? There's been plenty of talk about it. Now the National Society of Professional Engineers says that predictions and rumors concerning a so-called engineering shortage are "a disservice to the nation and the engineering profession," because they are not based on sound analysis. NSPE urges anyone who believes there is or may be a shortage to consider these points:

1. Engineering school enrollments are at an all-time high and are continuing to increase without artificial stimulation.

2. Action which may force-feed students into engineering curricula without adequate assistance to the over-burdened engineering schools can only harm the cause of engineering education.

3. The current engineering need in industry and advanced technology is one based on qualitative rather than quantitative factors. The serious technological problems facing the nation cannot be resolved merely by adding to the number of engineers.

4. Greater utilization of existing engineering manpower is recognized by all serious students of our manpower problems as a first priority item.

PROBABLY A FIRST in the engineering field, a comprehensive plan for leasing water, sewage and waste treating equipment, with option to purchase, is announced by Infilco Inc, of Tucson, Arizona. The plan can be applied to many types and sizes of equipment, and emphasizes that tax deductions become an advantage in the case of industrial customers. Also, payments out of revenue or other sources of funds where this is practical, rather than by bond issue, can be advantageous to municipalities and other public operations.

ENGINEERS JOINT COUNCIL has cited the Westinghouse Educational Foundation and the Carnegie Institute of Technology for pioneering the encouragement of young men and women to seek careers in engineering and science. The citation was formally presented by Enoch R. Needles, just re-elected president of EJC, to John A. Hutcheson, vice president in charge of research and development for Westinghouse and president of the Westinghouse Educational Foundation.

This year observes the completion of 20 years of George Westinghouse Scholarships at Carnegie Tech. Each year, since 1938, ten four-year scholarships have been awarded to secondary school seniors selected from over 1000 applicants per year, in nation-wide competition. The program represents a pioneering achievement in industry-education coöperation.

Newly elected to the vice-presidency of EJC is Dr. Augustus B. Kinzel, vice-president for research, Union Carbide Corp.

AT PUBLIC SERVICE Electric and Gas Co's $110,000,000 Bergen Generating Station in Ridgefield, N. J., it is expected that the first of two 290,000-kw turbine generators will be in operation this spring, with the second unit ready for operating later this year.

The company's Mercer Generating Station, located near Trenton in the heart of the Delaware Valley area, will have two 320,000-kw turbine generators with a total capacity of 640,000 kw and will cost approximately $130,000,000. First unit is scheduled to go into operation in 1960 and the second a year later.

Upon completion of the Bergen and Mercer Stations, the company's total effective capacity of the eight generating stations in the system will be 3,692,500 kw, an increase of 45 per cent over the capacity on January 1, 1958.

FREDERICK P. FAIRCHILD, chief engineer in the electric engineering department, Public Service Electric and Gas Company, who recently was presented the George Westinghouse Gold Medal Award of ASME for "eminent achievement and distinguished service in the power field of mechanical engineering," retired January 28.

Mr. Fairchild was an early advocate of pulverized fuel firing and the larger boilers which were thus made possible. He has been a consistent proponent of higher steam pressures and temperatures, which have resulted in marked improvement in efficiency and the better utilization of fuel resources.

He has been recognized not only for being the first to use austenitic steel in high-temperature, high-pressure power plant piping, but for promoting its continued use to the point where this alloy has attained acceptance by the industry.

Mr. Fairchild early encouraged manufacturers to develop the large capacity, high-speed, 3600-rpm turbine generators. He also was an early advocate of the all 3600-rpm cross-compound turbine into which he incorporated shaft-driven boiler feed pumps.

$60,251 CONTRACT from Southwestern Electric Power Co for general instrumentation, panels and automatic combustion control equipment has been awarded to Leeds & Northrup Co. The equipment will be installed at Southwestern's Arsenal Hill Station in Shreveport, La., and will automatically control a Combustion Engineering boiler with a capacity of 810,000 lb of steam per hour.

1958 FRANK NEWMAN SPELLER AWARD is being given to Aaron Wachter, director of research, Shell Development Corp, Emeryville, Cal. Award is made by the National Association of Corrosion Engineers in recognition of achievements in corrosion engineering. Dr. Wachter, who was 1954 president of NACE, has been head of Shell Development's corrosion department since 1938. He is an alumnus of City College of New York and has a PhD in physical chemistry from University of California.

Hoover Medal for 1958, awarded by ASCE, ASME, AIEE and AIMMPE, goes to Lt. Gen. Raymond A. Wheeler, past president and director of the Society of American Military Engineers. The award was made at a special dinner and meeting by the four sponsoring societies in Washington, D. C.

ANNUAL Spring Conference of the ASME Lubrication Division will be held March 16 and 17 at the Franklin Institute in Philadelphia. Theme of the conference is Wear of Lubricated Surfaces. Three of the sessions will be conducted as a symposium and formal papers will be presented at one session.

1959 Gas Turbine Power Conference is scheduled for March 8–11 at the Netherland-Hilton Hotel in Cincinnati. The meeting and exhibit are sponsored by ASME.

1959 Nuclear Congress will be a 40-session, 5-day meeting, which begins April 5 at the Public Auditorium in Cleveland. Featured will be engineering papers dealing with advances in reactor technology and the use of radioactive materials, a trade show, the ATOMFAIR, talks devoted to problems of industrial management in the nuclear field and papers devoted to laboratory problems in radioactive materials. Invitations have been issued to Russian engineers to describe details of their power reactor program, including a 600,000-kw power plant reported to be under construction in Siberia.

Wisconsin's triennial Engineering Exposition will be held at the University of Wisconsin College of Engineering, April 10–11–12. Biggest engineering project of its kind in the state, the 1959 exposition will house exhibits and displays in all four of the engineering buildings on the Wisconsin campus.

Annual conference of the Maintenance and Plant Engineering Division of the American Society of Mechanical Engineers will be held May 4 and 5, 1959, at the Edgewater Beach Hotel in Chicago. The conference will be co-sponsored by the American Institute of Plant Engineers.

portrait of a power hog

When water flow capacities go down and pumping costs go up, the culprit is usually *tuberculation*. The way to deal with this power hog is right on his own ground — the inner surface of the water main. Here Calgon,® the simple and inexpensive way to deal with corrosion,† goes to work. By interposing a tough film between the metal surface and water, Calgon definitely controls corrosion.

Calgon treatment of the water is particularly effective after mechanical main cleaning because of its fast film-forming ability. Protection for freshly scored metal surfaces is quickly built up and easily maintained. Calgon treatment is as inexpensive as it is effective — a few ppm control tuberculation and other corrosion problems as well.

A letter or phone call will bring you more information on how Calgon can help. Or, an experienced Calgon engineer will be glad to make detailed recommendations on your specific problem.

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WHAT THEY TELL US

▶ **IN CLEVELAND** recently we checked up with Henry Vyhnalek, chief chemist for Cleveland Electric Illuminating Co, on performance of the 107-mile coal pipeline that supplies the company's Eastlake Station. As readers will recall, this unique pipeline originates at Hanna Coal Co near Cadiz, Ohio, and terminates at the Eastlake Plant. Diameter of the pipeline is 10 in. and coal slurries in varying concentrations are pumped through it. Vyhnalek tells us that:

> Maximum concentration successfully pumped to date is 50 per cent slurry. Maximum daily tonnage to date has been 4700, which represents a return on investment of $4700 for that day. Economics of the operation is an even $1 a ton on the basis of rail freight rates in effect last October.

One of the problems connected with this unusual operation has been the clarification of the transporting water, so that it can be dumped into Lake Erie. This problem has been solved so well that the effluent water, after clarification, is better quality than Lake Erie water. Eastlake Station is using this water for cooling system and service water before returning it to the lake. For details, watch for an account in an early issue of POWER ENGINEERING.

▶ **NUCLEAR** power activity in Britain in 1958 was "tremendous," reports Dr. Tom Margerison, scientific editor of *The New Scientist*. Margerison says that:

> From the research center at Harwell, activities now spread wide over the country from Dounreay in the north of Scotland to Winfrith Heath on the south coast of England, where the first of a new generation of atomic reactors is being built.
>
> All around the coasts, nuclear power stations are beginning to take shape. At Berkeley in the west and Bradwell in the east the new stations are making rapid progress. The great shapes of the nuclear reactors already dominate the scene and also the tall heat exchangers, in which water is converted into steam for the turbines that generate electricity.
>
> Berkeley and Bradwell are the two most advanced of the Electricity Authority's nuclear power stations. They should be completed by the end of 1960. The two newer stations, at Hunterston on the west coast of Scotland and Hinkley Point in the southwest of England, will not be completed until 1962. In the meantime, the Atomic Energy Authority's station at Calder Hall has been completed and is now four times the size it was when it was opened two years ago, while another nuclear power station at Annan in the south of Scotland, identical with Calder Hall, is nearing completion.
>
> While the four major power stations are being constructed, sites are being found for new stations. These will be bigger and more economical than those now being built. As a result, the size of the British atomic power program has been increased from the 1400-mw target originally projected to around 5000 mw.

▶ **READER REACTION** to our standing offer to send tearsheets (free extra copies) to readers desiring them, often is not only gratifying but revealing of the way in which POWER ENGINEERING is used. E. R. Hottenstein, a mechanical engineer working in the nuclear energy division of Gilbert Associates, Inc, in Reading, Penna, writes:

> Your December, 1958 issue has just crossed my desk, and an article titled Introduction to Steam Power (Feedwater Treatment) which appears on pages 96 and 98 is of interest to me. Since the magazine circulates in our office to other engineers, I do not wish to mutilate it by tearing out pages. With this in mind, I would like to know if I could obtain a set of the respective tearsheets on this article.

▶ **"DON'T BE** misled by Kakorrhaphiophobia into osphresiolagnia." That was a sapient comment uttered by the famous Col. John Paul Stapp, the man who rode the rocket test sled at the Muroc Dry Lake in California at speeds up to 632 mph, the stops subjecting him to forces of well over 40 g's. He became the fastest man on earth. A recent article in the *Saturday Review of Literature* gives many details of Col. Stapp's heroic work in these tests and the practical results of it. This article quotes his comment given in the first sentence.

Now there is a very simple English translation of that comment. If you are curious about it, drop the Editor a post card or write Stapp on the return post card elsewhere in this issue.

▶ **SINCE** industry will be more and more vitally interested in training of crews for nuclear power plants, we asked Major Wray (see article on page 50 of this issue) about the differences, as he sees them, between the Army's nuclear power plant training problem and that which industry faces. Major Wray replied:

> Several factors appear to simplify greatly the training problem faced by industry. Most important among these factors are the following two:
>
> 1. There is available to industry a plentiful supply of personnel with many years of experience as operators and as power plant maintenance men. This fact eliminates the need for a major part of the effort required for the military — that of training men in the conventional aspects of nuclear power plant operation.
>
> 2. Generally speaking, cross training in maintenance and operation would not be required for personnel in a commercial plant.
>
> Analysis of industry's problem indicates considerably varying needs for personnel in different operational and maintenance positions. It would appear that guide lines for a training program could be summarized as follows:
>
> All personnel would be given a short course describing the basic systems in the nuclear power plant involved and the general principles of operation of the nuclear boiler.
>
> All personnel would require orientation in the field of health physics in order that they can appreciate and follow the radiological safety rules and procedures for the plant.
>
> All maintenance personnel would receive instruction covering any special equipment which they would be required to maintain. For instrument technicians, this includes the field of nuclear instrumentation.
>
> Plant chemists would probably be given some training in those techniques required for analyzing radioactive fluids and for assisting the plant health physicist in monitoring the plant and personnel for possible contamination and radiation exposure. For the present it would appear desirable for each plant to retain a professional level health physicist on the staff or on a frequent consulting basis.
>
> Not more than two men per shift would require training in reactor operation. This training, on a technician level, would be fairly extensive. By careful selection of experienced operators with somewhat better than average aptitude for learning, this phase of the instruction should not present a difficult problem.
>
> Practically no academic type of instruction would be required for crew members other than reactor operators. The instruction for the reactor operators would include only those subjects necessary to give them the necessary working knowledge of nuclear reactors.

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

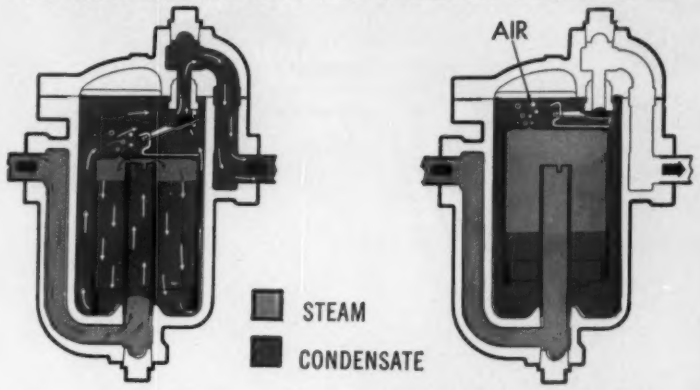
A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

Armstrong Machine Works
8103 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

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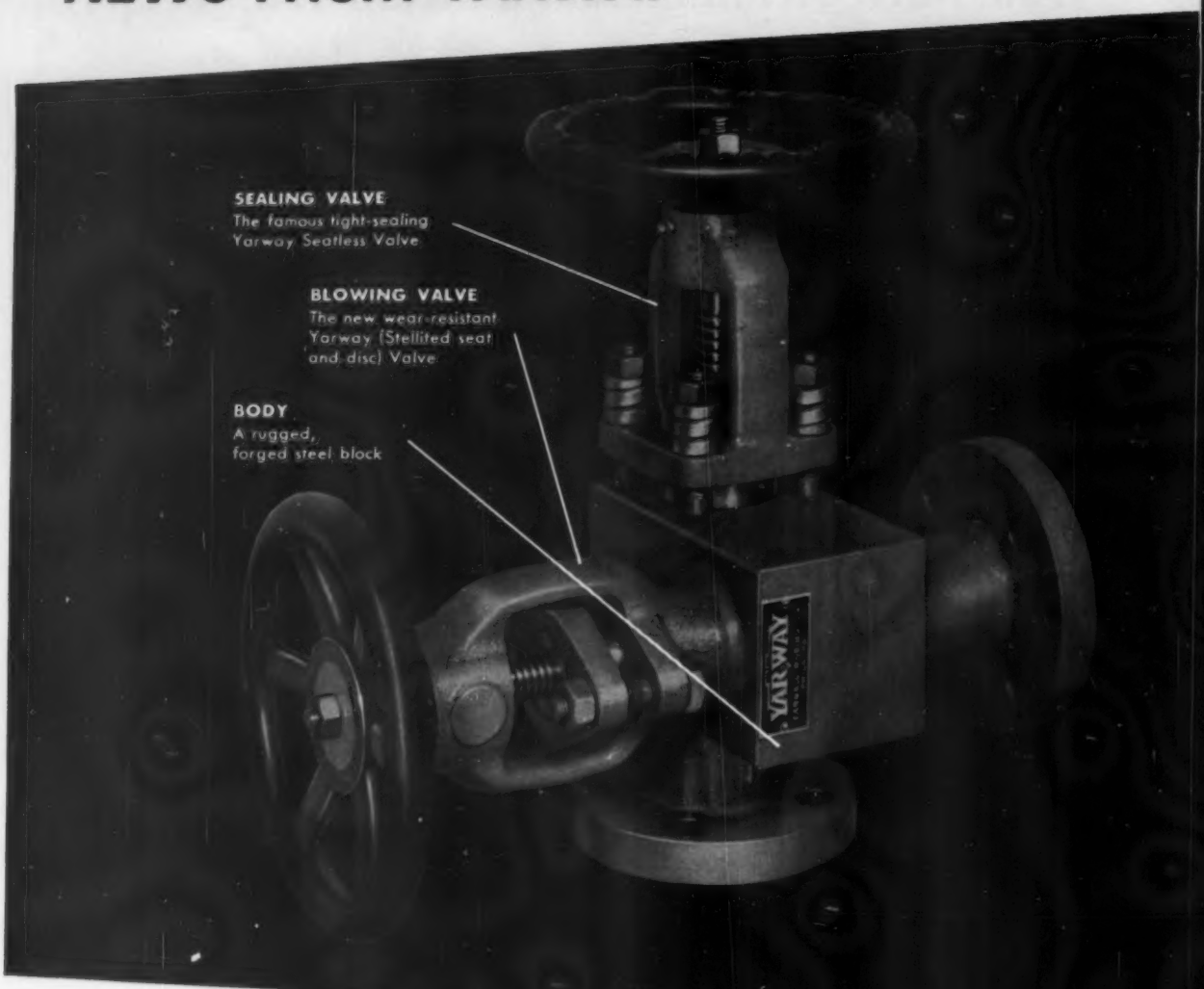
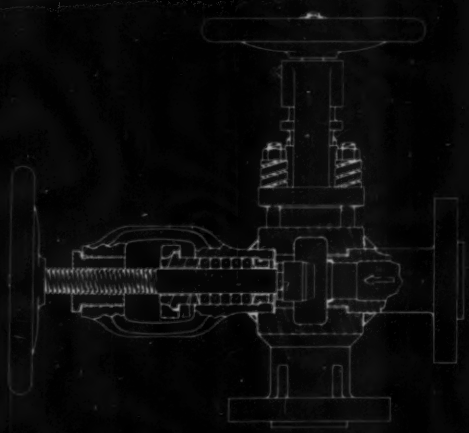
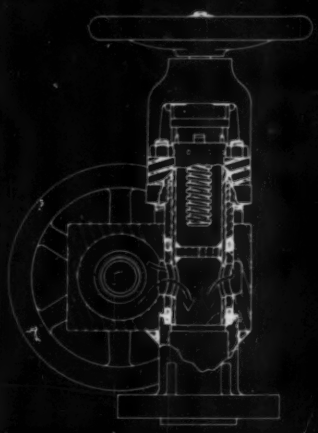


NOW! A NEW YARWAY BLOW-OFF VALVE FOR



Cross-section of medium pressure Unit Tandem Valve showing hard-seat blowing valve in open position.



Cross-section showing seatless sealing valve in open position. Flanged ends shown, welding ends also available.

UNIT TANDEM MEDIUM PRESSURE BOILERS

There's a new star in the Yarway Blow-Off Valve line.

For years rugged Yarway Unit Tandem Blow-Off Valves have been standard equipment on most high pressure boilers. In fact, more than 80% of high pressure plants use Yarways.

Now a *new design* Unit Tandem is offered for *medium pressure boilers to 665 WSP.* Streamlined, lighter in weight, easy to operate, tight sealing and long wearing —this valve brings premium quality Yarway Unit Tandem dependability to the medium pressure field— *at a competitive price!*

Important features, like the nitralloy plunger in the sealing valve and integral stellite seat and disc in the blowing valve, make this your best buy for blow-off service.

Order Yarway Unit Tandems for your present boilers— or specify them on new boilers.

For full details write for Yarway Bulletin B-435, Supplement A.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCHES IN PRINCIPAL CITIES

YARWAY

For more data circle 505 on Post Card

Now! Ready-to-install in a single package—

- **High-temperature insulation**
- **A protective metal jacket**
- **A built-in vapor barrier**

The insulation in Metal-On is Johns-Manville Thermobestos® . . . finest of all the calcium silicate insulations for service to 1200°F.

From carton to . . . with

Thermobestos calcium silicate insulation

5 SECONDS TO REMOVE Metal-On from carton. Another 25 seconds to snap on pipe and lock in place!

15 SECONDS LATER the specially designed aluminum "snap strap" (containing vapor seal) has been snapped on joint.

METAL BAND provides perfect joint protection against vapor and weather. Total elapsed time: 90 seconds!

Here's the fastest, most efficient way ever to install high-temperature pipe insulation and protective aluminum jacketing.

Metal-On is the insulation idea all industry has asked for: a single package product that permits application of Thermobestos pipe insulation and corrosion-resistant metal jacket in one fast operation. You'll find that a section of Metal-On can be applied as fast as, oftentimes faster than, an insulation alone.

Snaps in place . . . F-A-S-T!

J-M's new Metal-On consists of Thermobestos calcium silicate insu-

Metal-On ends jacket thickness and alloy guesswork! The Metal-On jacket measures an ideal .016-inch thick . . . of a high-quality aluminum alloy selected for superior weather resistance.

pipe in 90 seconds!

new J-M METAL-ON Insulation!

factory-jacketed in gleaming, weatherproof aluminum

lation, a vapor barrier and an all-weather protective covering of aluminum. Furnished ready-to-install, a section of Metal-On snaps on the pipe, locks tightly in place (new locking device is exclusive Metal-On feature) to seal out weather and protect the insulation indefinitely. Joints are sealed tight with aluminum "snap straps" mechanically fastened in place with metal bands.

Right alloy . . . proper thickness

The Metal-On aluminum jacket reduces maintenance in virtually every outdoor pipe application! It never needs painting . . . won't rust . . . is impervious to surface dirt, oils and grime. The jacketing is made of an aluminum alloy (containing magnesium) that is specially selected for superior corrosion resistance. Jacket thickness is designed to provide, at lowest cost, outstanding appearance, stiffness, workability and resistance to abuse and pitting.

Metal-On presents no fitting problem. It is cut easily right on the job with either power or hack saws. Available in 36″ sections in a complete range of pipe sizes through 24″ . . . by 3″ thickness.

To help you investigate Metal-On for your next pipe insulation requirement, let us send you the informative brochure, IN-217A. Write for it today. Address Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE

JOHNS MANVILLE JM PRODUCTS

For more data circle 506 on Post Card

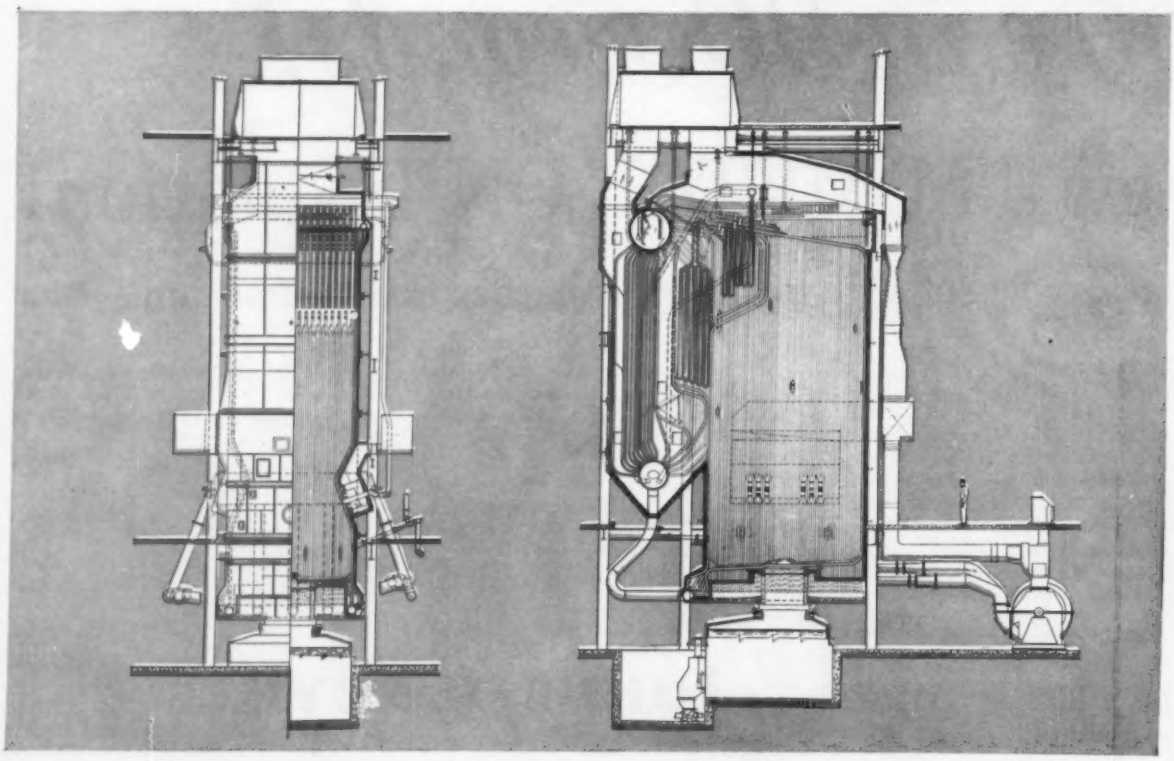
These Three Companies Selected The
RILEY TURBO FURNACE
Because Of These Outstanding Performance Characteristics

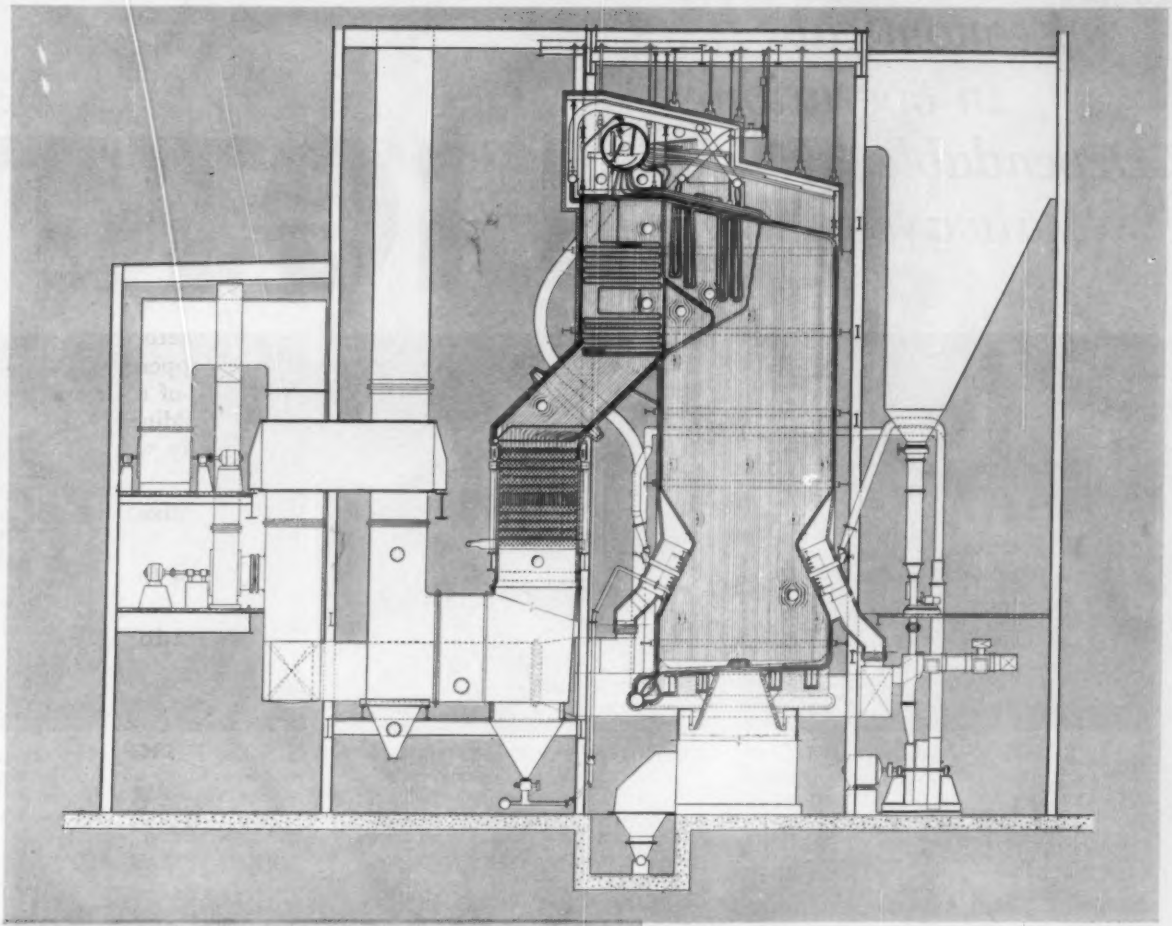
- Eliminates the flyash disposal problem
- Clean furnace walls eliminate necessity of wall deslagging equipment
- High operating efficiency — minimum carbon loss — low excess air
- Uniform distribution of furnace gases across full width of the superheater with minimum variation in metal skin temperatures from side to side
- Maximum utilization of waterwall surface
- Economical and quick conversion from gas and oil firing to coal
- Because of performance characteristics, the Riley Turbo Furnace can be operated at higher heat releases: The size of the unit is reduced thus reducing building costs and permitting higher capacity within a given space
- A wide furnace is possible without need for dividing walls
- One level firing reduces expense for walkway systems
- Provides ease of observation and operation

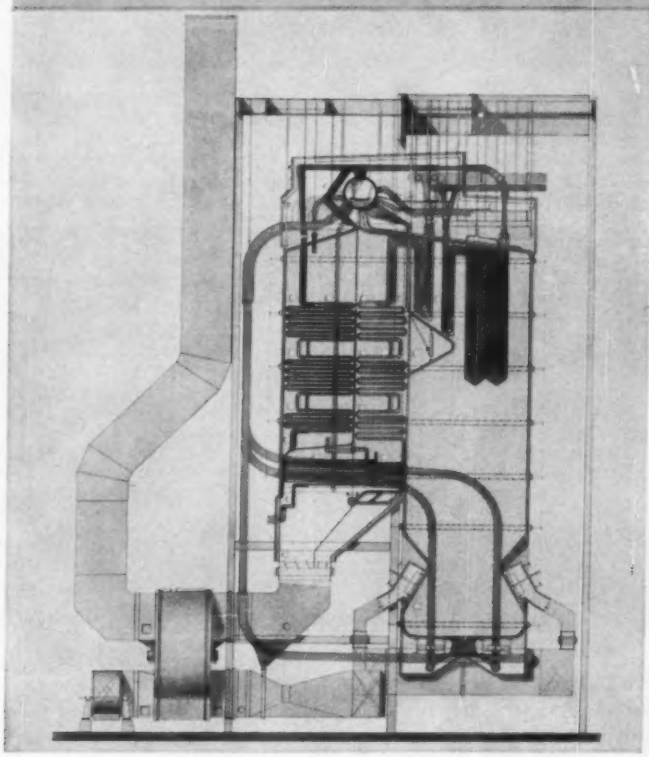
FOR TURBO FURNACE DETAILS — WRITE RILEY STOKER CORPORATION, WORCESTER, MASSACHUSETTS

A survey of your plant by a qualified consulting engineer could show ways of making surprising savings in your power costs.

RILEY
STEAM GENERATING & FUEL BURNING EQUIPMENT







A Progressive Chemical Company

One 400,000 lbs/hr Turbo Furnace Boiler: 830 F — 1250 psig. Unit is fired by pulverized coal from three Riley Pulverizers. A second Turbo Furnace Boiler of 600,000 lbs/hr has been purchased for a second plant at this location.

A Louisiana Public Utility

One 1,550,000 lbs/hr Turbo Furnace Boiler; 1005 F superheat, reheat — 2175 psig. This unit has a furnace 55 feet wide with no water cooled platens or dividing walls. Fired by natural gas. Can be converted to coal quickly and at low cost.

A Prominent Manufacturer of Electrical and Electronic Equipment

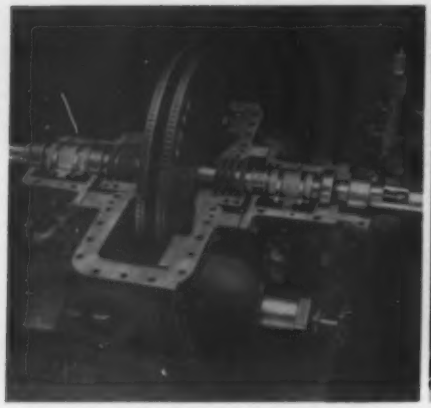
One 150,000 lbs/hr Boiler: 835 F — 900 psig; Fired by pulverized coal. One Duplex Riley Pulverizer.

For the full operating facts of Riley Turbo Furnace Boilers consult your Riley representative.

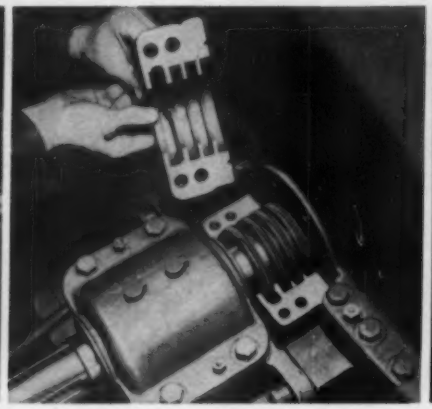
For more data circle 507 on Post Card

Economical in operation...
Dependable always

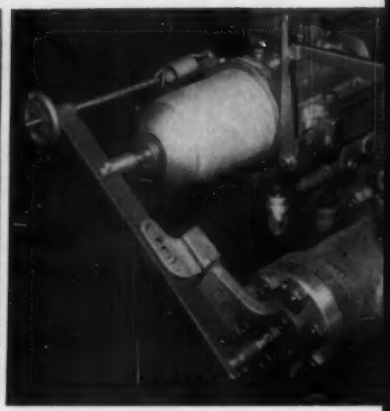
ELLIOTT



Precise alignment of shaft, through true centerline support, permits smooth and dependable operation at all operating temperatures. The entire rotor assembly is dynamically balanced.



Accessible shaft-seals simplify maintenance and routine inspection. Shaft surface under packing glands is stainless steel. Covers are readily removable without disturbing the upper-half casing.



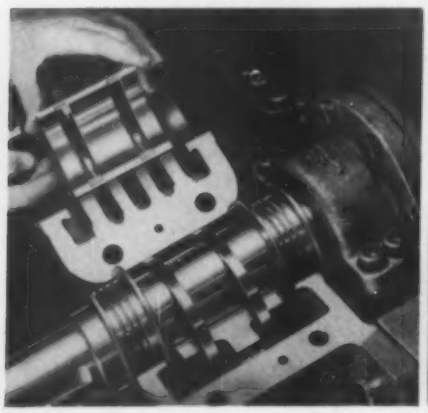
Simple, Positive direct-acting speed-governing system is dependable, weather-proof, accurate. Separate trip gives positive overspeed protection, and it may be easily reset against line pressure.

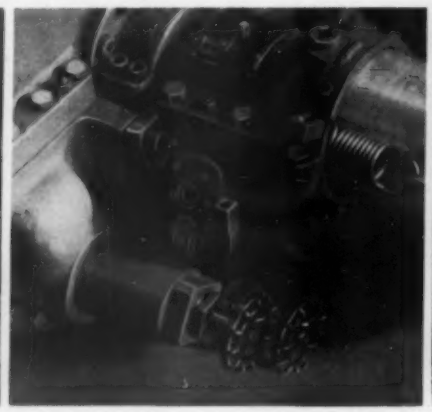
Only ELLIOTT Turbines give you all these PLUS features

By separating the pedestal-mounted exhaust-end bearing from the hot turbine casing, the temperature distortion is minimized, and the vertical shaft movement is thereby eliminated.

Steam-saving hand valve with pilot, which can be opened against full steam pressure, reduces steam consumption at partial loads. This feature is available on all sizes of Elliott YR steam turbines.

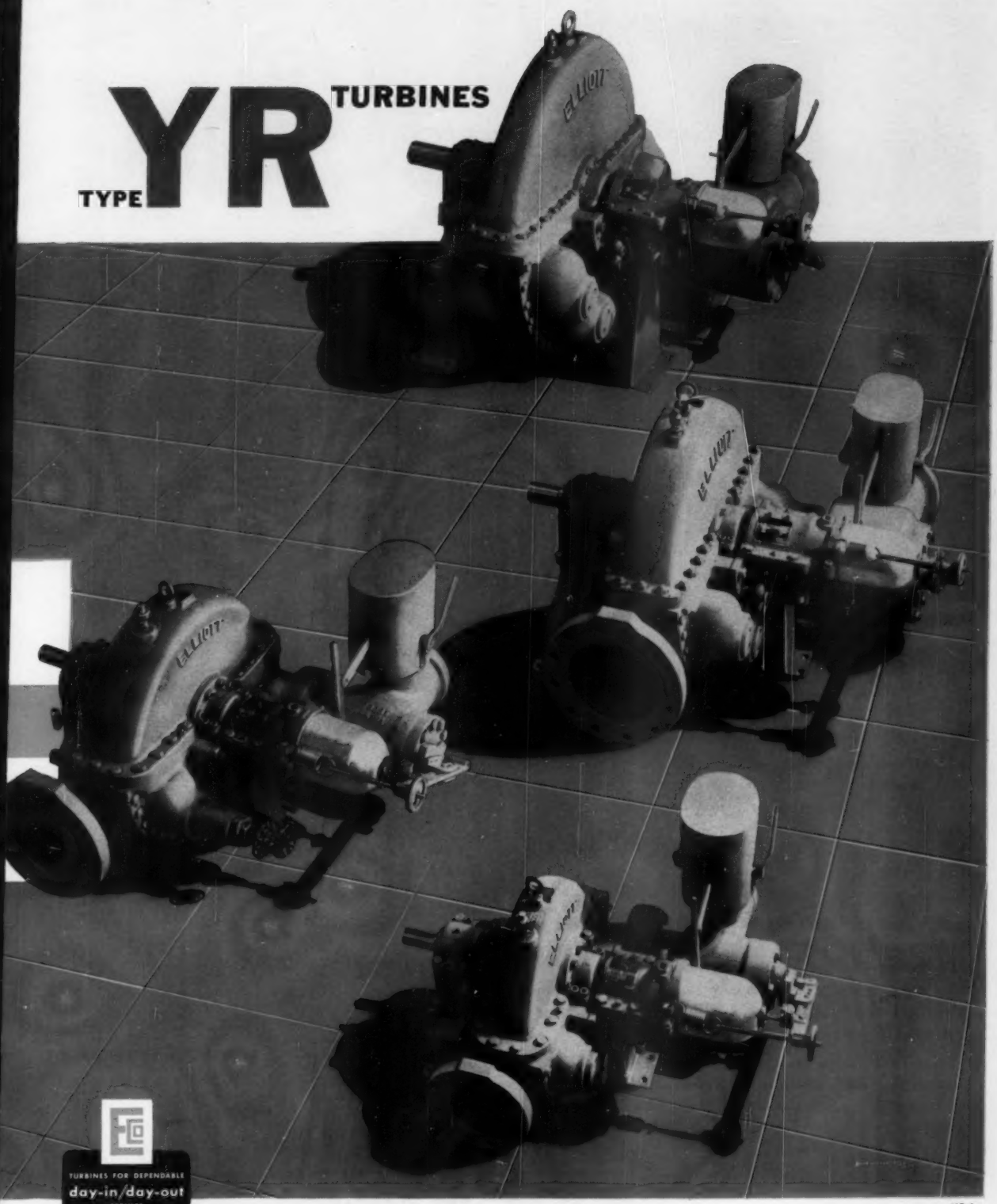
All-weather protection is standard for Elliott YR turbines. They shrug off heat, dirt, snow, moisture or contaminated atmosphere. Stainless steel exposed parts are furnished for extreme conditions.





In addition to the units illustrated here, Elliott makes single-stage turbines in special frames, reduction gears, multistage mechanical drive turbines to 50,000 hp, and turbine-generators ranging through 44 mw.

TYPE YR TURBINES



TURBINES FOR DEPENDABLE
day-in/day-out
SERVICE

HB-1

ELLIOTT Company JEANNETTE, PENNA.

For more data circle 508 on Post Card

A plant built on the philosophy of "don't accept anything at face value"...

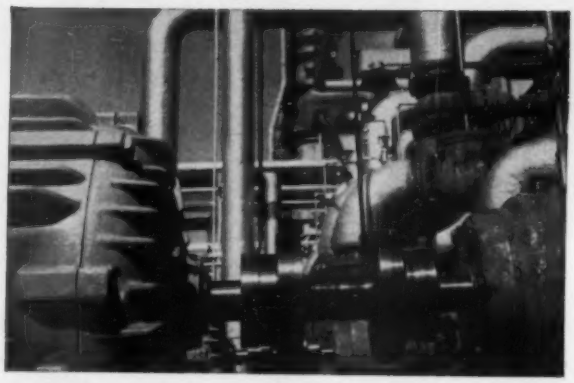
Tidewater's "Refinery of the Future" Uses 471 Fast's Couplings to Reduce Maintenance

IN PLANNING Tidewater's Delaware Refinery, all equipment purchases were examined from every angle . . . capital investment, manpower, maintenance and reliability. Fast's Self-Aligning Couplings were used throughout because they met Tidewater's exacting demands.

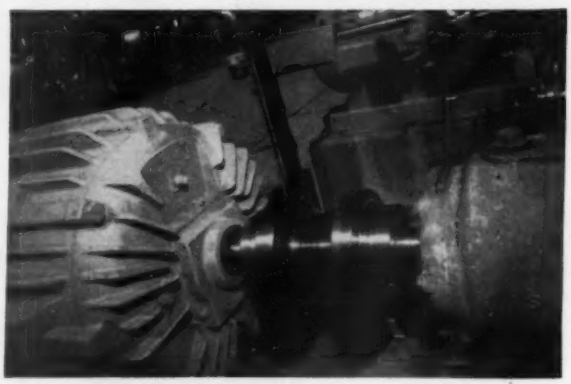
Tidewater's equipment design policies were established by survey teams that visited refineries all over the country. They carefully appraised each plant and asked operators what improvements they would make and what features they would retain if they were to redesign their drives.

In 471 applications at this refinery, Fast's Couplings guarantee mechanical flexibility that eliminates costly shutdowns and expensive shaft replacements. Fast's have the reputation of frequently outlasting the equipment they connect. This means savings in maintenance and down-time . . . in addition to protecting costly equipment against errors of alignment.

Nearly 40 years of coupling experience qualifies Koppers to solve *your* coupling problem. Write today for full details to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 3502 Scott Street, Baltimore 3, Md.



Fast's Couplings give dependable, trouble-free service throughout Tidewater's entire production facilities.



This Fast's Coupling drives a pump delivering heavy naptha @ the Solutizing plant.

Engineered Products Sold with *Service*

KOPPERS

THE ORIGINAL

FAST'S Couplings

For more data circle 509 on Post Card

Be sure you are near the world's largest Coal Reserves for a low-cost, unlimited fuel supply

Since your fuel costs are governed to a large extent by transportation charges, it is *good business* to locate your new plant near a large, dependable reservoir of coal. PEABODY, with two billion tons of proven reserves, can help you select that site . . . where your burning equipment can be fed from one of PEABODY'S ultramodern mines and coal processing plants. Result: your assurance of an economical coal supply far into the future. Long-range planning is an important part of our business. May we be of service to YOU? *Get your free booklet, "This Is Peabody Coal Company", and learn more facts about PEABODY and its complete coal service. Write Department PE.*

power for progress

PEABODY COAL COMPANY

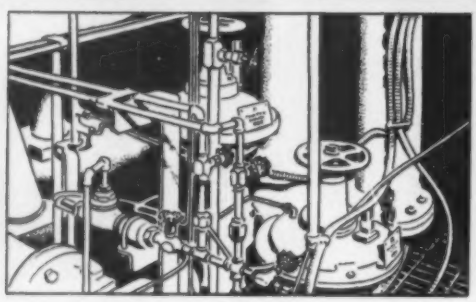
Peabody Plaza, 301 Olive Street, St. Louis 2, Missouri

GENERAL OFFICES: PEABODY PLAZA, ST. LOUIS. OFFICES IN: CHICAGO, DES MOINES, KANSAS CITY, LOUISVILLE, MEMPHIS, MINNEAPOLIS, NASHVILLE

For more data circle 510 on Post Card

Where metal costs less than plain water

SALTY, SANDY WATER IN CIRCULATION PUMP GLAND SEALS AT A COASTAL POWER PLANT CUT SHAFT SLEEVE LIFE BELOW 2½ YRS. USE OF FRESH WATER IN PACKING GLANDS WOULD HAVE REDUCED ABRASION, CORROSION. BUT THERE WAS A CHEAPER WAY. "S" MONEL* HARD-GRADE NICKEL-COPPER ALLOY SLEEVES, PRODUCED AT INCO'S BAYONNE FOUNDRY, WERE INSTALLED. NOW IN SERVICE 4 YEARS ...NO REPLACEMENTS...THE COST OF "S" MONEL SLEEVES WAS LESS THAN THE ESTIMATED COST OF PROVIDING FRESH WATER FOR LUBRICATION.



"Free" samples...free from impurities at new ion exchange

IT TAKES A MAZE OF SMALL TUBES TO PICK UP SAMPLES OF TREATED WATER, CAUSTIC SODA, AND WATER RINSES FROM AN ANION EXCHANGER. BECAUSE OF A CONSTANT CORROSION PROBLEM CAUSED BY ACID REGENERATION, MONEL ALLOY IS USED FOR THE TUBES, FITTINGS, AND FIXTURES THROUGHOUT THE SAMPLING SYSTEM OF AN EASTERN POWER PLANT'S NEW ION EXCHANGE SYSTEM.

Alloy Plugs for leaky heat exchanger tubes put an end to galvanic corrosion, too

PLUG'S SHAPE PREVENTS TUBE SHEET DAMAGE, MAKES CERTAIN PLUG IS DRIVEN IN CONCENTRIC WITH TUBE. OF MONEL* NICKEL-COPPER AND INCONEL* NICKEL-CHROMIUM ALLOYS, PLUGS ARE CORROSION-RESISTING AND GALVANICALLY COMPATIBLE WITH HEAT EXCHANGER TUBE MATERIAL.

SLOWED DOWN BY A METAL PROBLEM?

A TALK WITH ENGINEERS FROM INCO'S MECHANICAL ENGINEERING SECTION MAY HELP YOU GET BACK ON SCHEDULE. JUST GET IN TOUCH WITH US AND OUTLINE THE DETAILS. AND FOR A USEFUL RUN-DOWN ON MONEL ALLOY, WRITE DEPARTMENT **PE** FOR 30-PAGE INCO BULLETIN, "ENGINEERING PROPERTIES OF MONEL AND 'R' MONEL ALLOYS."

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street
New York 5, N. Y.

INCO TRADE MARK

*Registered trademark

INCO NICKEL ALLOYS

For more data circle 511 on Post Card

CITY OF MANITOWOC INSTALLS SIXTH WICKES BOILER

R. E. Cannard—Chief Engineer and General Manager

Manitowoc Public Utilities Commission has just installed the sixth Wickes Steam Generator to help provide power for the City of Manitowoc, Wisconsin, and its surrounding area. The continued selection of Wickes equipment by this progressive municipality is a tribute to the dependability and quality of Wickes Steam Generators.

Wickes Boiler Co. builds steam generators for all branches of industry . . . for municipalities and for private and public buildings. Wickes units are available in sizes up to 500,000 lbs. of steam per hour and are designed for high or low steam pressures and temperatures, and for all types of fuels and firing methods. There is a Wickes design available for your needs.

Write for bulletin 55-1, showing the wide variety of designs and sizes available in both field-erected and shop-assembled* steam generators, or ask the nearest Wickes representative to call on you for full information.

*For the latest developments in shop-assembled boilers, investigate Wickes natural circulation A-type water tube units now built for capacities up to 75,000 lbs. per hour for oil and gas fuels. Request bulletins 56-1 and 57-1 for full information.

170

WICKES

WICKES BOILER CO., SAGINAW 11, MICHIGAN
DIVISION OF THE WICKES CORPORATION
RECOGNIZED QUALITY SINCE 1854 • *SALES OFFICES:* Boston • Chicago
Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles
Memphis • Milwaukee • New York City • New Orleans • Portland, Ore.
Saginaw • San Francisco • Springfield, Ill. • Tulsa

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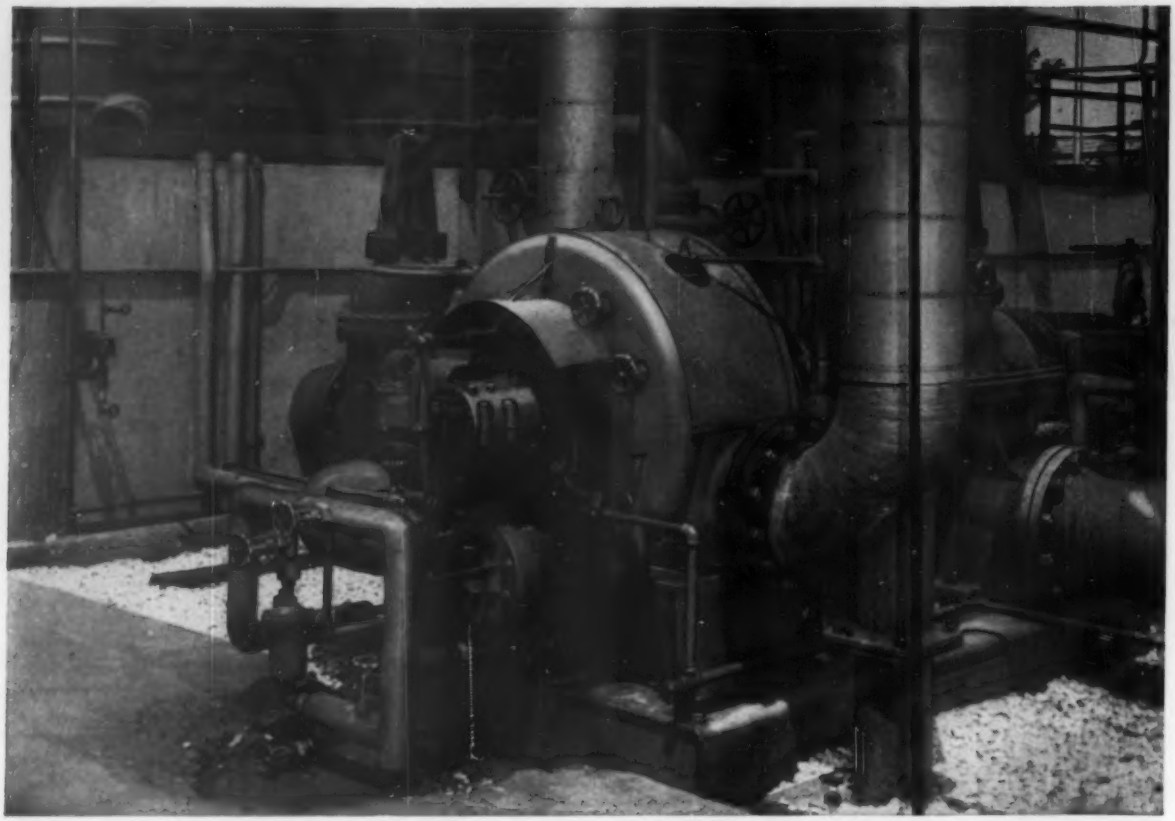
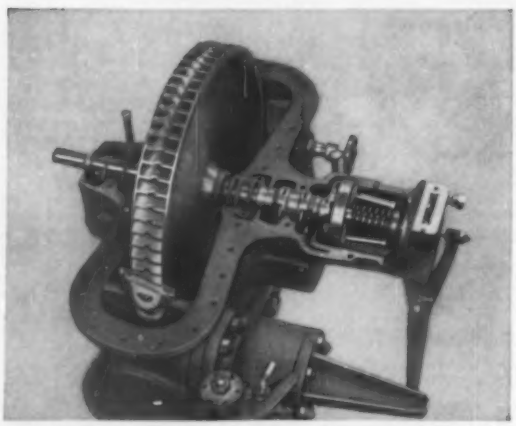


TERRY SOLID-WHEEL TURBINES

used exclusively at Baton Rouge plant of W.R.Grace & Co.



The upper photograph shows one of the 17 Terry turbines installed at the Baton Rouge, La., GREX high-density polyethylene plant of W. R. Grace & Co. Above, a typical Terry solid-wheel turbine with cover removed to show the wheel construction.

In purchasing equipment for their new 50,000,000-pound high-density polyethylene plant, W. R. Grace & Co. standardized, wherever possible, on a single source of supply for each type of equipment used. Consistent with this policy, Terry steam turbines were used exclusively throughout the utility and process sections of the plant.

A total of 17 turbines were placed in service for driving pumps and fans. These are all of the solid-wheel type, ranging in capacity from 50 to 240 HP.

Terry solid-wheel turbines are known for their long life and sure dependability under the most-trying operating conditions. They feature a single-piece wheel which is virtually indestructible.

Send for details of these trouble-free turbines. Ask for a copy of bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1214

For more data circle 513 on Post Card

look
what's
new
in

metering pumps

new streamlined safety shield
new crank-type design
new improved accuracy
new parts interchangeability
new operational efficiency
new maintenance ease

all for a new lower price

Send for new booklet giving the biggest news in pumps...

See how the all-new Hills-McCanna Masterline metering pump can bring you new highs in economy and performance. This booklet tells the story . . . gives you the details on the pumps that go new *inside* and *outside* to register all-time highs in accuracy, dependability and maintenance ease.

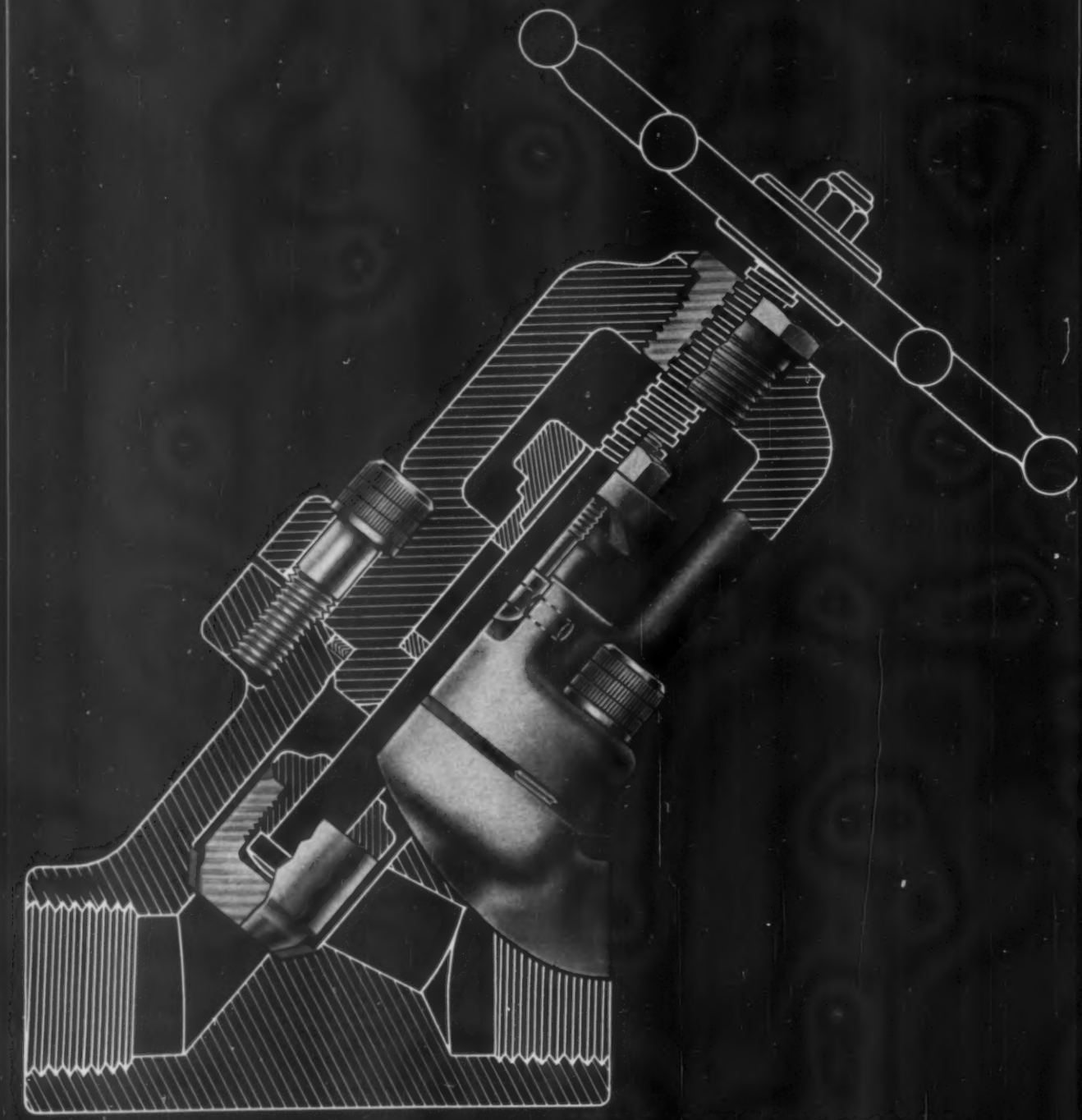
Ask for Bulletin #900 "Look What's New in Metering Pumps"... it pinpoints the features that make Masterline pumps your best buy for now and the *future!*

Hills-McCanna Company, 4620 W. Touhy Ave., Chicago 46, Ill.

hills-mccanna company

THE PEOPLE WHO KNOW AND CONTROL FLOW

For more data circle 514 on Post Card



EDWARD "848" SERIES GLOBE VALVE
(ANGLE TYPE ALSO AVAILABLE)

What's New from Edward Valves

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

Major Improvements at No Extra Cost Mark New "848" Series Forged Steel Stop Valves

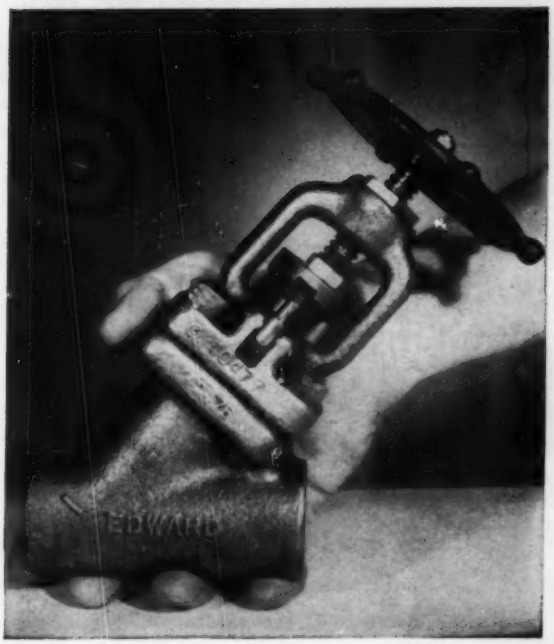
In an industry where any change in design is "news," Edward is proud to introduce a new line of 600-lb forged steel stop valves with so many major design improvements *at no increase in cost.* These Rockwell-built Edward valves are suitable for air, water, oil and other hydrocarbons, anhydrous ammonia and other gases, steam and other non-corrosive fluids.

NEW MATERIALS USED THROUGHOUT

Besides tough drop-forged steel, which is the basis of these valves, Edward introduces such innovations as stainless steel gland bolts, an aluminum-bronze yoke bushing, solid disk of chromium-cobalt-tungsten stainless steel, spiral wound gasket of stainless steel and asbestos, and special alloy cap screws linking body and bonnet.

NEW IMPROVED BODY-BONNET JOINT

Four molybdenum alloy cap screws secure bonnet to valve body. These compact, high-strength cap screws require less space than ordinary nuts and bolts, can be handled with one hand, and deliver maximum compressive force with minimum tightening torque. A new spiral wound gasket, consisting of some 20 turns of stainless steel and asbestos, provides controlled compression not possible with ordinary flat gaskets. Because this spiral wound gasket is free to expand and contract as needed, it "takes up the slack," maintains a leak-proof seal between body and bonnet.



NEW SOLID DISK OF SPECIAL ALLOY

Disk is made of chromium-cobalt-tungsten stainless steel. This new alloy has added resistance to erosion, holds its hardness better under high temperatures than other disk materials. Disk is lock-welded to disk-nut, eliminating wobble and chatter—especially important when valve is called upon for throttling duty.

INTEGRAL STELLITE SEAT FOR LONG LIFE

Valve seat is Stellite—a harder, longer-wearing material with excellent resistance to corrosion, erosion and temperature. Seat is integrally welded to body.

"848" SERIES ROCKWELL-BUILT EDWARD VALVES are available in ¼", ⅜", ½", ¾" and 1" sizes. They are rated at 600 psi—at 910F in carbon steel and at 1030F in chrome-molybdenum steel. Globe or angle types, with screwed or welding ends. Write for facts on performance . . . price . . . and delivery. Address *Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana.* (Subsidiary of Rockwell Manufacturing Company.) Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame St. W., Montreal 1, Quebec.

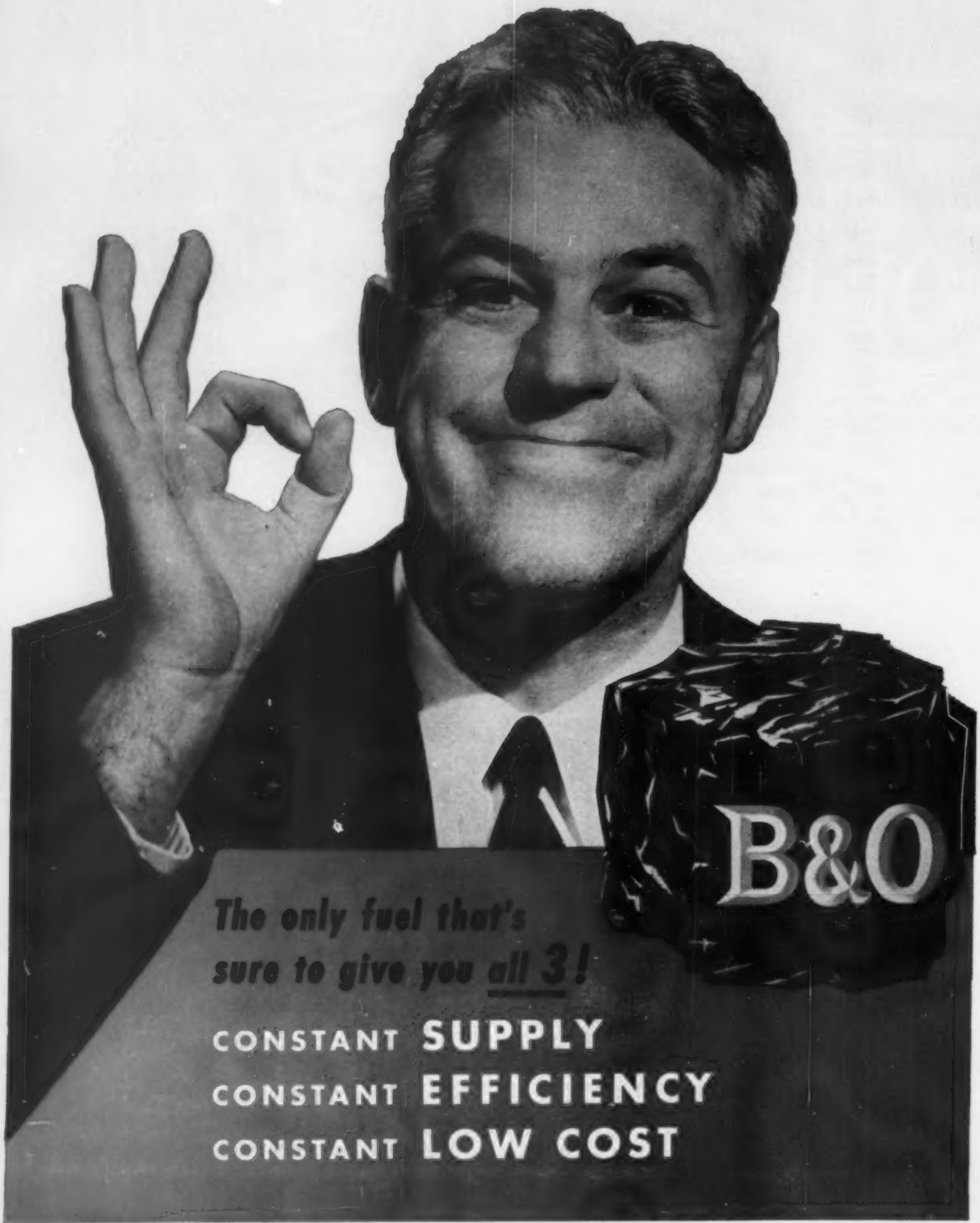
EDWARD STEEL VALVES

another fine product by

ROCKWELL

Catalog 14 contains full data on the complete Edward line of forged and cast steel valves from ¼" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressure up to 10,000 lbs; with pressure-seal, bolted, union or welded bonnets, with screwed, welding or flanged ends.

For more data circle 515 on Post Card



B&O **BITUMINOUS COALS FOR EVERY PURPOSE**

Ask our Man! BALTIMORE & OHIO RAILROAD, BALTIMORE 1, MD. *Phone* LExington 9-0400

For more data circle 516 on Post Card

HELPFUL BULLETINS

VALVES, PIPING, FITTINGS

101 General Service Valves — Twenty-pp Bulletin E-165 is a guide to valves or general services. Types, typical applications, construction and operating features are discussed. Generously illustrated with drawings, photos and cutaways, booklet includes dimensional data. Everlasting Valve Co.

102 Corrosion-Resistant Valves — Eight-pp Bulletin 11 describes stainless steel valves with replaceable Teflon discs or seats for corrosive services. Illustrates globe, Y, check, needle and plug gate designs, as well as some with complete jacketing. Specification data and application information is included. Alloy Steel Products Co., Inc.

103 Butterfly Valves — Bulletin 650.20–1 describes 125-lb class butterfly valves, providing cutaway drawings and photos of the higher pressure models, plus installation photos and information on choice of operators. Also included are dimensional data and cross-section drawings of the valves designed for line sizes from 4 to 48 in. B-I-F Industries, Inc.

104 Bonnetless Gate Valve — Sixteen-pp Catalog 300 introduces a forged steel gate valve, up to 2 in., designed to prevent leakage, provide tight shut-off and permit fast servicing in the line. Major design advantages are discussed and illustrated. Cutaways show ease of removal and replacement of wedge and stem and of seats. Bulletin includes engineering data, also comparison of this valve with conventional models. Velan Valve Corp.

105 Reducing Valve — This illustrated catalog sheet describes a reducing valve for initial pressures to 300 psi with gas, oil or water. Gives features, operating and ordering information, dimensions, parts list. Atlas Valve Co.

106 Blow-Off Valves — Bulletin B-435 describes company's unit tandem blow-off valves for boiler blow-off pressures to 665 psi, basic pressure rating 400 psi. Contains full description, operating details, and data on materials, dimensions, and advantages. Yarnall-Waring Co.

107 Surge Relief Valve — Bulletin W-2-A, 8 pp, tells how company's surge relief valve protects water lines against overpressure in the system. With this valve, the line pressure itself supplies the power to operate the valve automatically. Engineering information, detailed drawings and suggested specifications are provided. Golden Anderson Valve Specialty Co.

108 Solenoid Valves — Featured in 12-pp Catalog 2000 are high-pressure solenoid valves for hydraulic power systems. Included is descriptive and dimensional information, as well as diagrams and pressure drop charts for two-way and three-way valves in both a-c and d-c models. Waterman Engineering Co.

109 Wrought Iron Pipe — Featured in this 64-pp bulletin is comprehensive information on 4-D wrought iron piping for soil, waste, vent and downspout applications. Contents are divided into nine sections, including reports of building piping surveys with photographic examples of vent corrosion, descriptions of the corrosive conditions encountered in drainage services, comparative service records, typical installation and performance tables. A. M. Byers Co.

110 Swing Joints — Twelve-pp Catalog F-8 describes and illustrates swing joints of bronze, steel, Monel and aluminum for a wide range of industrial requirements. Discusses design advantages of the line and provides material specifications. Includes dimensional data and service instructions, also shows replacement parts. Jordan Corp. Div., OPW Corp.

PUMPS, COMPRESSORS

111 Utility Pumps — Featured in this 8-pp bulletin are company's utility pumps which incorporate the helical screw principle and have no vanes, turbines or impellers. Advantages and operation are detailed and tables of dimensions and capacities, and performance data are included. Continental Pump Co.

112 Proportioning Pump — Bulletin 1106.20A-1 describes the Proportioneers Model 1106 Adjust-O-Feeder for general industrial fluids. Contains photos of simplex and duplex models, a capacity table, dimensional line drawings and descriptive data. B-I-F Industries, Inc.

113 Compressor Advances — Five advances achieved by company to increase operating efficiency of reciprocating pipeline compressors are described in 14-pp Bulletin 168. Describes low ratio compressor cylinders, poppet-type valves, use of electronic brain to calculate performance, development and use of analog computer to calculate header sizes for optimum flow, advances in control and automation. Clark Bros. Co.

INSTRUMENTS, CONTROLS

114 Electronic Receiver — Eight-pp Bulletin OE-1003 lists specifications for the PowrLog H-O receiver as used in temperature, pH and conductivity measurement and a-c and d-c closed circuit telemetering. Contains 10 schematic drawings showing applications of the instrument, including those for d-c voltage and current measurement and a-c and d-c signal transmission and summation. Hagan Chemicals & Controls, Inc.

115 Electronic Instruments — Complete specifications of company's potentiometer and bridge instruments in indicating, recording, and controlling models are presented in 64-pp Bulletin P1245-A. Information on new rack mounting instruments, high-speed and multi-point instruments and miniature ones is included, also descriptions of standard round-chart and strip-chart instruments. A section is devoted to descriptions of sensing elements and attachments. The Bristol Co.

116 Flow Rate Transmitter — Bulletin 170 contains 12 pp of design and operation information on company's line of rotameter flow rate transmitters. Cutaway diagrams illustrate component details. Performance data and capacities table are included. Brooks Rotameter Co.

117 Pressure Elements — Described in 8-pp Technical Bulletin 11P-1000 are bellows, bourbon tube and liquid filled types of pressure elements. Gives specifications of those suitable for pressure ranges between the limit of 30-in. Hg vacuum and 5000 psig, and lists ranges for the various types in different applications. Fischer & Porter Co.

118 Temperature Monitor — Reliable, low-cost temperature detection using company's monitor unit is described in 30-pp Publication 3036C. Details of operation, specifications, connections, installation and other information are provided. Specifications, accessories, and a table of temperature/resistance characteristics are also included. Instrument Div., Thomas A. Edison Industries, McGraw-Edison Co.

119 Temperature Probe — Bulletin 1048 describes a moving temperature probe which patrols critical boiler gas passages and warns of incipient hot spots during lighting-off. Explains how device protects boilers during periods most likely to involve damaging temperatures. Also includes structural details and specifications of the probe as well as explanation of methods of control. Copes-Vulcan Div., Blaw-Knox Co.

120 Plug Valve Actuator — This 22-pp brochure gives data on plug valve actuators designed for remote or automatic control operation of a wrench operated plug valve. Included are specifications, dimensions and torque information, as well as revised and expanded selection tables and other data. Pantex Mfg. Corp.

Postage-free cards for ordering bulletins are on page 113. You may also use the cards to order literature mentioned in the ads.

121 Diesel Engine Controls — Illustrated and described in 24-pp Bulletin B45-1 are controls for diesel engines. Describes temperature and pressure control systems for diesel engines, safety devices, tachometers, control motors, valves, switches, relays and related accessories. Schematic diagrams, specifications given. Minneapolis-Honeywell Regulator Co.

FANS, BLOWERS

122 Rigid Plastic Fans — Fans made of polyvinyl chloride and claimed to offer exceptional chemical resistance with high structural strength in relation to weight are described in these two bulletins. Bulletin 9–20 describes centrifugal fans, and Bulletin 9–21 details features of the twin-flow fans available in sizes from 12 to 48 in. The Atlas Mineral Products Co.

123 Roof Ventilators — Construction features, capacities, quietness levels and accessories of company's centrifugal type roof ventilators are covered in 8-pp

Bulletin 4004. Capacity table and table of relative quietness levels are included, as well as dimension data, photos and specifications. American Blower Div., American-Standard.

124 Blowers and Exhausters — Bulletin B-7, 24 pp, describes company's line of centrifugal type blowers and exhausters for air or gas. Operating features are detailed and sectional views showing design and construction details are included, as well as general specifications, capacity and rating tables, and a section on fundamental engineering laws for blower and exhauster applications. Lamson Corp.

MECHANICAL POWER TRANSMISSION

125 For Power Transmission —This bulletin presents mauufacturer's line of power transmission equipment. Contains brief description of major features of speed reduction drives; screw conveyor drives; adjustable speed drives; motor bases; and conveyor and split pulleys. Size ranges are listed. The American Pulley Co.

126 Precision Gears — High-performance, precision gears from less than 1-in. to over 200-in. diam, and with ttooth-to-tooth spacing accuracies of two ten-thousandths of an inch are described in 24-pp Bulletin GEA-6430. Design features and advantages are fully detailed and performance results described. Photos and diagrams illustrate details of design and operation. General Electric Co.

127 Worm Gear Reducer — Complete horsepower and torque data for company's worm gear units built on 2½ up to 4-in. centers are given in full-page tables in Bulletin 5018. Dimensions are diagrammed and tabulated in detail, and materials and design of interchangeable components are described. De Laval Steam Turbine Co.

128 Worm Gear Speed Reducers — Twelve-pp Catalog HSDR-58 features detailed information on company's double reduction hollow shaft worm gear speed reducers. Contains parts indexes, unit dimensions, dimensions for high speed and slow speed shaft bores, plans and elevations of shaft arrangements, tables of weights, as well as complete horsepower, torque and overhung load ratings and AGMA service factors for selecting worm gear type reducers. Winsmith, Inc.

129 Integral-Shaft Sheaves — Construction and operating features of Vari-Pitch integral-shaft sheaves for low-cost stepless speed control in large machine drives are given in 6-pp Bulletin 20B7897B. Tells how sheaves are available with lube systems designed to assure distribution of lubricants to moving parts. Allis-Chalmers Mfg. Co.

130 Pillow Blocks — Catalog 100, 8 pp, presents pillow blocks for heavy industry — a line including 20 basic housings that will accommodate 94 spherical roller bearings. Detailed specifications are given, showing how different end caps may be used with the one-piece housings to fit all series of spherical roller bearings. Price list included. Miether Machine Works.

131 Flexible Couplings — Bulletin 205, 6 pp, describes standard and special bonded rubber flexible couplings. Contains specifications for three standard shear-type couplings, 1/50 to 100 hp at 1750 rpm. Formula for selecting standard coupling for other speeds is given. Custom-engineered couplings are shown in typical installations indicating a wide range of sizes and torque capacities. Lord Mfg. Co.

ELECTRICAL

132 On Turbine-Generators — Forty-pp Booklet B-7373 describes turbine generators from 5000 to 100,000 kw for industrial and electric utility applications. Booklet is divided into two sections, a section on turbines presenting standard and special features. This section is arranged for easy reference relating to condensing and non-condensing turbines, blading, shrink fitted discs, steam chest, bearings, rotors, etc. Includes description of hydraulic governing system. The section on generators presents both air-cooled and hydrogen-cooled types. Westinghouse Electric Corp.

133 Distribution Regulator — Ratings, dimensions, capabilities of a three-phase distribution regulator (Type SFR), along with description of optional equipment, are provided in 6-pp Bulletin 21B-9026. The regulator offers savings in size, weight and cost, and comes in several self-cooled and air-cooled ratings. Among control panel features is Caliband test circuit. Allis-Chalmers Mfg. Co.

134 Voltage Regulator — Six-pp Bulletin 6.04 describes a 60-finger regulator for direct control of voltage of main fields of large alternators and generators; line load regulation, power amplification; impedance matching and system stabilization. Basic types and variations, circuitry, and typical applications are covered. Electric Regulator Corp.

135 Isolated Phase Bus — Bulletin GEA-6874, 12 pp, gives detailed information on the features and application of company's unit-supported isolated phase bus with zero force design that reduces fault current stress on conductors and insulators. Includes photos, cutaway and line drawings, rating and dimension tables, line drawings of flexible bus arrangements, and information on bus for generator currents above 8,000 amp. General Electric Co.

136 Underfloor Raceways — Illustrated with drawings and photos, 52-pp Catalog 539B gives complete information on a variety of underfloor distribution systems. Also covered are service fittings, boxes, and saddle supports. Suggested specifications, typical layouts, application and installation information, and data tables and charts are included. National Electric Products Corp.

137 High Voltage Control — This 16-pp booklet discusses general features of company's high voltage control equipment. Details individual characteristics of both full and reduced voltage types of high voltage control for squirrel cage, synchronous and wound rotor motors. Ratings, dimensions, optional features listed. Cutler-Hammer Inc.

138 For Control Panels — Bulletin 104 illustrates and describes five accessories for use with control panel information systems. They include remote liquid level indicators, interlock receptacles for use in hazardous areas, mercury pushbutton and selector switches for Class I Div. 2 locations, plug-in relay tester, mechanical pushbutton switches. Panellit, Inc.

139 Low Voltage Protector — Eight-pp Bulletin GEA-6527 provides detailed information on application, features and operation of company's Type LB-1 power protector for heavy-duty commercial building applications, 480 v a-c and below. Provides tables, charts, curves, guide form specifications, dimensions and ratings. General Electric Co.

140 Metal-Clad Switchgear — Construction and design features of company's 4.16-kv horizontal drawout metal-clad switchgear with "Ruptair" circuit breaker are described in 12-pp Bulletin 18 B 6346C. Features and advantages are detailed and illustrated, and cutaway views, dimensional diagrams and specifications included. Allis-Chalmers Mfg. Co.

141 Magnetic Starters — Bulletin EN-150 contains 15 pp of detailed information on a-c magnetic starters for both reversing and nonreversing single phase and squirrel cage motors. Component units and elements, including magnet coils, overload relays, contact assembly, enclosure types, are fully described, and ratings and dimensional data included. Cutler-Hammer Inc.

142 Time Switch Selection — Catalog 159, 8 pp, shows how to select a time switch and includes a section devoted to the explanation of switching and timing. Typical wiring diagrams and explanations of "what switches what" are provided, also a formula for selection of the proper timing. Gives data on standard time switches, special types. Tork Time Controls, Inc.

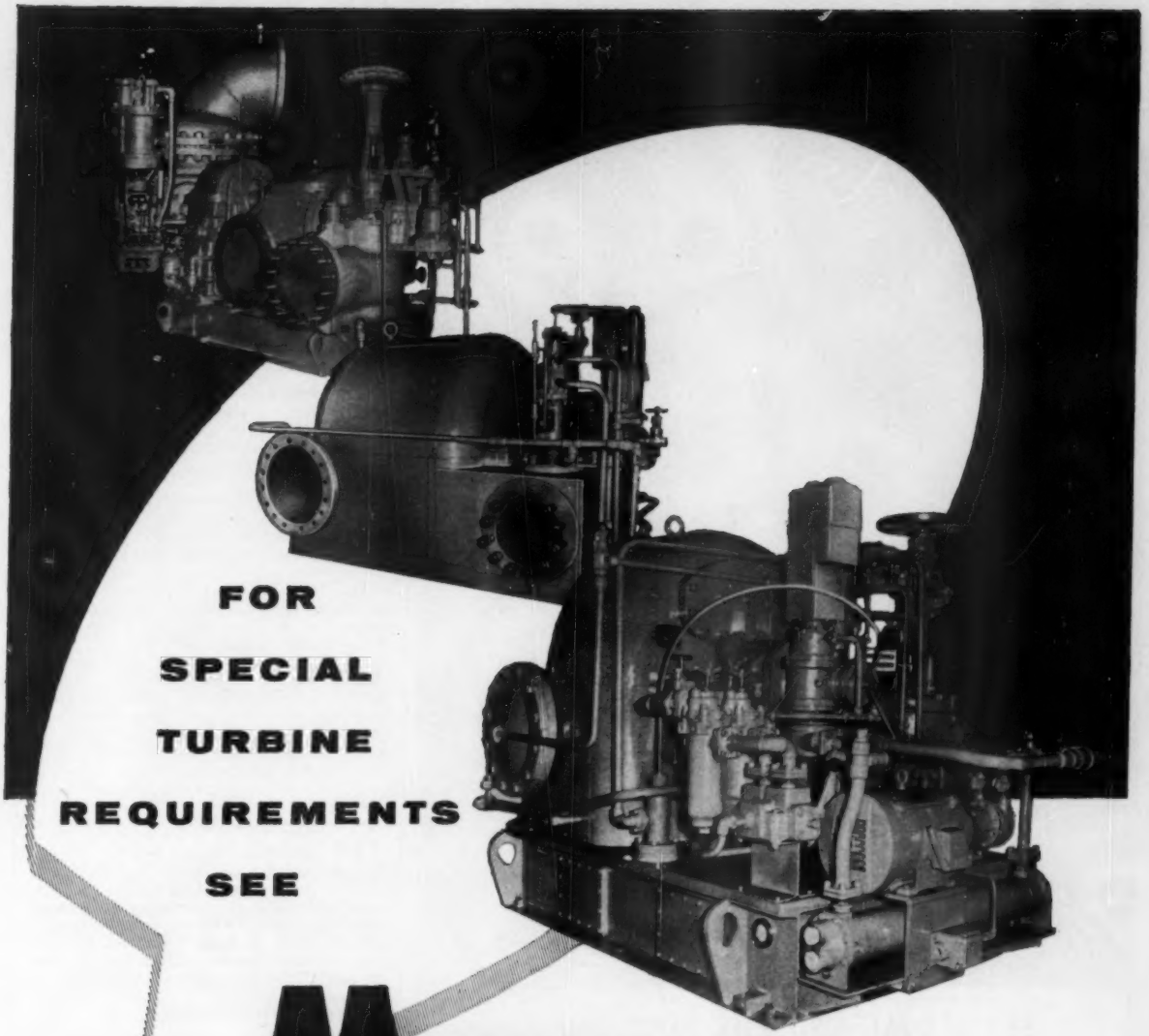
143 Storage Batteries — Selection information on heavy-duty nickel cadmium storage batteries for industrial engine starting and standby power applications is provided in NICAD Bulletin 200. Covers batteries for engine starting, supervisory control, emergency lighting, switch tripping. Diagrams show how batteries can be installed in space conserving rack arrangements. NICAD Div., Gould-National Batteries, Inc.

144 Ceramic Transducers — This 8-pp technical brochure covers Glennite high temperature, piezoelectric ceramic transducers. Describes their high Curie points which enable reaching higher output voltages per unit input pressure. Lists some applications of these components in industrial and other fields. Gulton Industries, Inc.

145 Aluminum Rigid Conduit — Data on company's line of rigid conduit couplings and 90 deg aluminum conduit elbows is presented in this 6-pp booklet. Diameter and length dimensions, weights and packaging details are given for all standard trade sizes. Details advantages of aluminum conduit and lists typical applications in a variety of industries. Kaiser Aluminum & Chemical Sales, Inc.

LIGHTING

146 Floodlight Data — Floodlight Catalog 320 contains 184 pp of comprehensive design and selection data on floodlights, searchlights and special lighting equipment. In 14 sections, includes divider sheets with individual table of contents for each. Section headings include selection of floodlights, heavy duty floodlights, general purpose floodlights, mercury vapor floodlights, special lighting fixtures, haz-



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Murray TURBINES

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Our nearest representative will help you solve your turbine requirements. His name gladly sent on request.

MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA

Builders of Steam Power Equipment for Nearly a Century

For more data circle 517 on Post Card

AIRETROL pneumatic tube expansion control shown. Electric systems, including retractive units, also available.

WITH AIRETOOL TUBE EXPANSION CONTROLS, WORKERS ROLL MORE TUBES PER DAY. THEY JUST PRE-SET A DIAL AND THE TOOL SHUTS OFF AT DESIRED TUBE EXPANSION. *ACCURACY?* WITHIN .001" EVERY TIME. ELIMINATES OPERATOR ERROR. OFTEN DOUBLES DAILY PRODUCTION. WRITE FOR PLANT DEMONSTRATION OR BULLETIN.

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BRANCH OFFICES: New York, Chicago, Philadelphia, Tulsa, Houston, Baton Rouge.

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ardous area lighting, searchlights, underwater floodlights, floodlight poles, accessories, installation suggestions, calculations. Book is available to qualified power engineers, please state your job title when requesting it. Crouse-Hinds Co.

147 Vaportight Fixtures — Catalog Section F, 12 pp, on vaportight lighting fixtures, includes specifications, dimensional data with outline drawings and application information for components and assemblies of interchangeable pendant, ceiling and wall fixtures. Large cutaway photos show outstanding features of the units. Stonco Electric Products Co.

GENERATORS, AUXILIARIES

148 Packaged Generators — Booklet PG-58-2, on packaged steam generators, covers features, standard and optional equipment, capacities and dimensions. Foster Wheeler Corp.

149 Steam Generator — Bulletin 582 CS describes design and operation features of company's vapor water tube steam generator which differs from conventional water tube steam generators in that initial heating and final vaporization occur in the shell. Schematic diagram is included, as well as specifications and dimensions. TXT Texsteam Corp.

150 Firing Units — Bulletin 28 describes steam atomizing packaged firing units for oil and/or gas fuels. Gives advantages of the units, specifications and general dimensions, and other data. National Airoil Burner Co., Inc.

METALS

151 Ductile Irons — This 28-pp booklet contains the full story of Ni-Resist ductile irons that combine strength and toughness with resistance to heat, wear and corrosion. Tables and graphs explain mechanical and physical properties, erosion and corrosion resistance, high temperature strength. Also presented are numerous industrial applications of the ductile irons. The International Nickel Co., Inc.

152 Alloy Fabrication — Detailed information on how to fabricate Hastelloy alloys is presented in 36-pp Booklet F-30. Step-by-step procedures and recommendations for welding, machining, grinding, others, are included, as well as information on lining of vessels and corrosion surfacing, along with boiler code data. Haynes Stellite Co., Div., Union Carbide Corp.

OTHER EQUIPMENT

153 Which Wire Cloth? — "Which Inco Nickel Alloy Can Solve Your Wire Cloth Problem?" is a 16-pp booklet covering use of wire cloth for filters, core-support structures, other applications. Describes physical advantages of wire cloth and indicates range of weaves and sizes available. Mechanical properties of four standard alloys used are given, along with list of products commonly filtered with such wire cloth. Case histories detail use of Monel alloy wire cloth. The International Nickel Co., Inc.

154 Condenser Cleaner — Bulletin Sheet A-24 introduces the lightweight Model CC-375 designed to clean severely clogged tubes to 1-in. diam. It is operated with a single-stage gear driven motor. Bulletin gives specifications, stresses af-

How to beat the high cost of temperature control

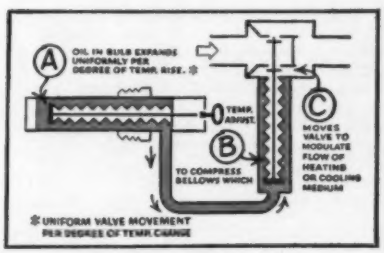
The practical approach to temperature control

By John W. Ritter, Test Engineer, SARCO Company, Inc.

Precise temperature regulation is essential in many processing operations, not only for quality control, but for maintenance of output as well.

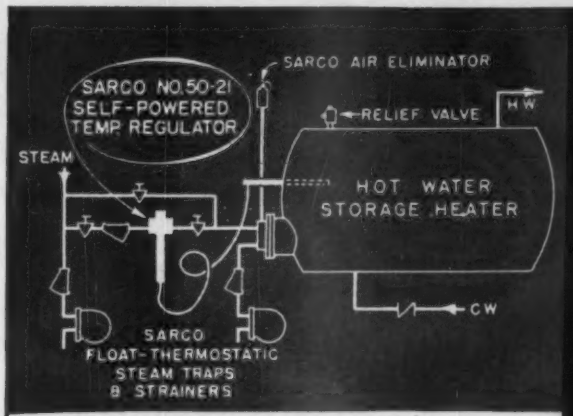
Manual temperature control is unsatisfactory because of the possibility of spoilage and loss of quality control which can result from irregular or indifferent hand regulation.

Automatic controls are available in a wide variety, including pneumatic, electronic, and self-powered. Pneumatic and electronic controls are relatively expensive to purchase and install, and may require frequent maintenance. However, in most applications, control requirements can be achieved very successfully by the use of relatively simple, economical Sarco Self-powered Regulators.


A
OIL IN BULB EXPANDS UNIFORMLY PER DEGREE OF TEMP. RISE.*
TEMP. ADJUST.
B
TO COMPRESS BELLOWS WHICH
C
MOVES VALVE TO MODULATE FLOW OF HEATING OR COOLING MEDIUM
*UNIFORM VALVE MOVEMENT PER DEGREE OF TEMP. CHANGE

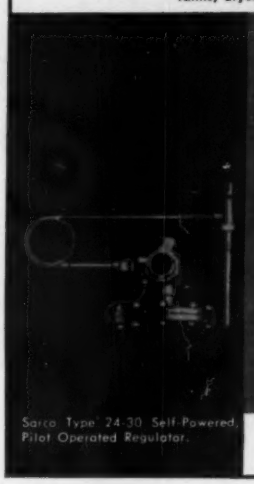
This drawing shows simplicity of operation of the Sarco 50-21 Temperature Regulator, which consists of a thermostat, capillary tubing, and a valve.

Sarco controls, like the 50-21 and the 24-30, have the required degree of sensitivity and dependability, combined with the ruggedness inherent in the sealed capillary tube construction. Because these Sarco controls do not depend on external power, such as electricity or compressed air, they have established long records of sustained, reliable operation. They are an economical and practical solution to the problem of maintaining continuous watchdog duty over processing temperatures.

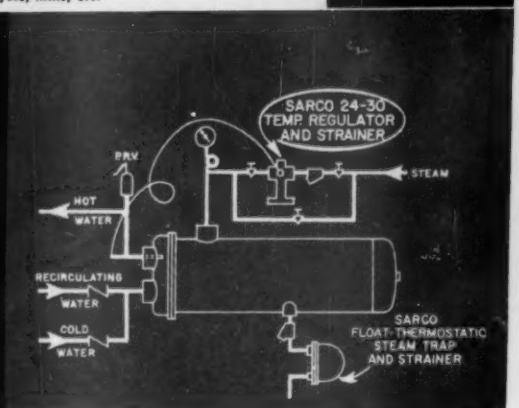


Typical applications: hot water storage heaters, shell and tube heat exchangers, condensers, oil storage tanks, dryers, kilns, etc.

Sarco Type 50-21 Self-Powered Regulator.



Sarco Type 24-30 Self-Powered, Pilot Operated Regulator.



Typical applications: instantaneous heaters, fuel oil preheaters, and all dead-end service applications.

Self-powered automatic temperature regulators by SARCO . . .

have these 5 marked advantages: No compressed air or electrical wiring required. No delicate mechanisms to adjust or maintain. No packing glands to stick or require maintenance. No shutdown during power failure. No specialized maintenance required.

Sarco Self-Powered Controls are self-contained and can be installed by any pipe fitter. They are so reasonable in cost that you can afford Sarco automatic heating controls for every application in your plant. Write for 10-page Sarco Control Bulletin No. 620.

6346-B

SARCO
COMPANY, INC.
635 Madison Ave., New York 22, N. Y.

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES

For more data circle 519 on Post Card

ROTO Hand-hole Seat Scraper

Roto Hand-hole Seat Scraper for B & W Boiler.

Eliminates tedious labor

Assures clean, tight fit

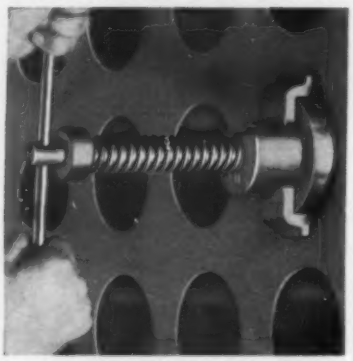
Roto Hand-hole Seat Scraper makes short work of cleaning dirty hand-hole seats. This simple, hand-operated tool has adjustable, spring-mounted retractable knives. A few turns to the right remove foreign matter without cutting the metal. A half turn to the left releases the tool, and the job is done. Customers say that the Roto Seat Scraper does the job up to 12 times faster than by any other method. Try one and you'll wonder how you ever got along without it. *Send for details.*

Now available

for most hand-hole shapes and sizes

ROUND SQUARE DIAMOND PEAR OVAL

Standard Roto Seat Scrapers are available for the following equipment. Special types made to order



Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Type of Boiler	Opening	Tube Size
Babcock & Wilcox # 4	Round	2"
" " " #41	Oval	2"
" " " #70	Round	3"
" " " #48	Oval	3½"
" " " #40	Oval	3¼"
" " " #24	Oval	4"
" " "	Oblong	4"
Bros	Round	3¼"
Casey Hedges	Oval	3½"
" "	Oval	4"
Combustion Eng'rg	Round	3"
" "	Oval	3"
Edgemoor	Oval	4"
Erie City	Ellip	2½"
" "	Oblong	3¼"
" "	Ellip	3¼"
" "	Pear	4"
Foster Wheeler	Oblong	2½"
" "	Oblong	3"
" "	Ellip	4"
Geary	Oblong	4"

Type of Boiler	Opening	Tube Size
Heine	Round	3½"
"	Oval	3½"
International Boiler 2	Oblong	3"
Keeler	Round	3½"
"	Round	4"
"	Diamond	3½"
"	Diamond	4"
Lasker	Oblong	
Murray	Oval	3½"
"	Oblong	4"
Oil City	Oval	3½"
" "	Oblong	4"
Riley Stoker	Ellip	3¼"
Springfield	Ellip	3¼"
Union Iron Works	Pear	4"
Henry Vogt	Ellip	3¼"
" "	Oval	4"
Walsh & Weidner	Oval	4"
Wickes	Ellip	2½"
"	Ellip	3¼"
"	Pear	4"
"	Round	4"

ELLIOTT COMPANY – ROTO PLANT

Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

forded time- and cost-saving advantages of the tool. Airetool Mfg. Co.

155 Deaerating Heater — This bulletin describes the Uni-Pac deaerating heater, a rolled plate jet-tray unit, for small and medium size power plants. Discusses design flexibility and other features of the heater, and explains operating principle. Includes capacity and dimensional data. Cochrane Corp.

156 Silicone Products — This 16-pp 1959 Reference Guide tells which silicones can best meet the needs of a variety of problems ranging from adhesives to water repellents. Contains examples showing where company's silicone products are being used, and tells how to get specific data on the silicone material best suited to any application. Well illustrated, this book features an expanded indexing system for quick location of more than 150 products. Dow Corning Corp.

157 Clarifiers, Thickeners — Bulletin W-800-D contains 16 pp of detailed information on clarifiers and thickeners for use in water, industrial waste and sewage treatment. Design and operation information on clarifiers and thickeners is furnished, as well as specifications, dimensions, sectional diagrams, typical drive mechanisms. Infilco Inc.

158 Power Unit — This folder describes a differential-pressure power unit and its use as a power source for industrial and other plants using gas. Explains operating principle of the unit which converts what would otherwise be unused energy into useful work, and shows a typical application. Troy Engine & Machine Co.

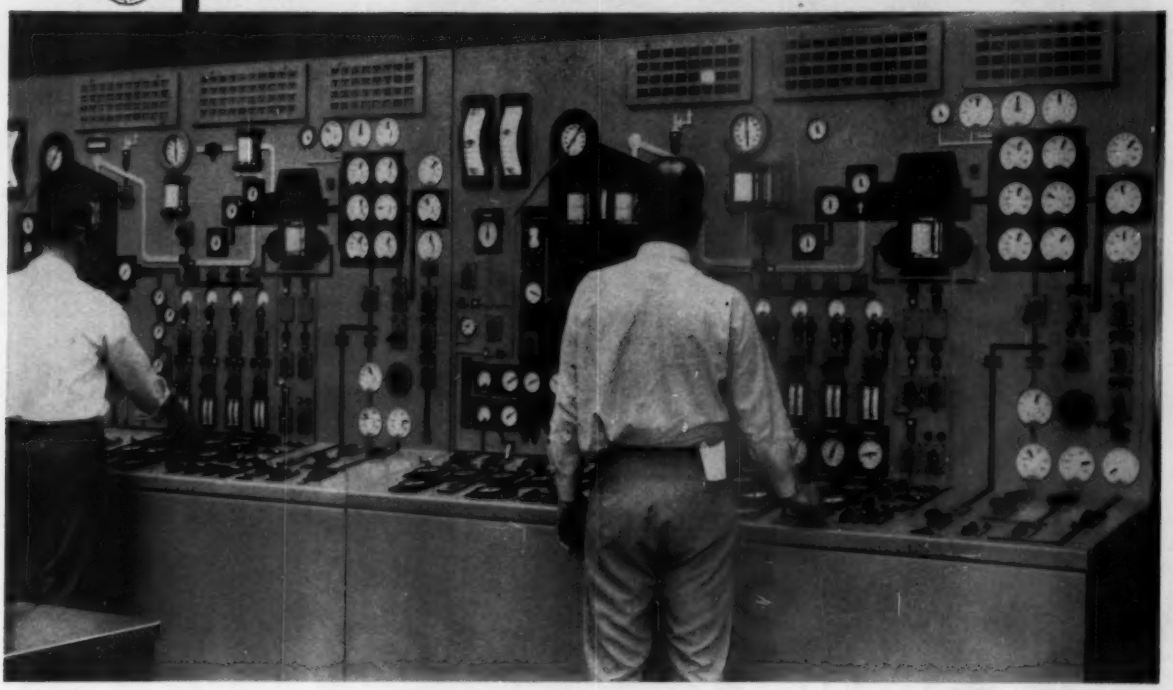
159 Struts, Snubbers — Eight-pp Catalog 229A describes and illustrates ball-type flexible struts for structural applications and Vibrasnub hydraulic vibration snubbers. For each product line, catalog explains operation, provides specifications and illustrates engineering applications. Also discusses advantages of the flexible struts and includes design and installations notes. Barco Mfg. Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 113 and 114.

160 Acoustical Products — In this 8-pp 1959 catalog of manufacturer's acoustical materials are presented: Styltone, a non-combustible fissured mineral tile; Panatone, a non-combustible perforated metal pan acoustical system; Claritone, a perforated cellulose fiber tile; and perforated asbestos board. Physical and acoustical characteristics are given, including flame resistance, and light reflectance, also sound absorption coefficients. Illustrated installation instructions provided. Baldwin-Hill Co.

161 T-M Conversion Chart — This compact chart enables quick conversion of Fahrenheit or Centigrade temperatures, in 5-deg increments, to millivolt values for eight thermocouple calibrations. Chart folds in half to 8½-by-11 in. size and is punched for use in binder. Temperature-emf values are in accordance with Na-

How Copes-Vulcan control systems boost power plant efficiency



Copes-Vulcan puts combustion control at operator's finger tips

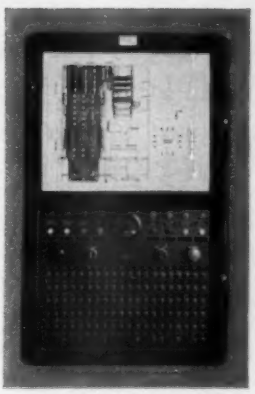
Equipped with easy-to-read recorders and control stations, this compact Copes-Vulcan panel centralizes operator control and simplifies boiler operation. This modern system features circuit simplicity with independent control loops on air flow, fuel loading and furnace draft. Drive units assure accurate positioning and fast response, and eliminate the need for interconnecting control loops.

A custom installation . . . a continuing service

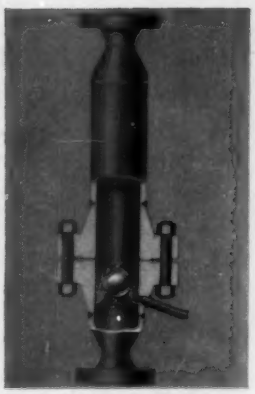
Copes-Vulcan Combustion Control is just part of an integrated boiler control system for regulating feed water, boiler steam temperature and boiler cleaning.

Whether furnished in individual units or integrated into a single system, each installation is tailored to meet specific requirements of generating capacity, load range and fuel. Copes-Vulcan supplies skilled service, when needed, for the life of the installation.

Write for Bulletin 1032 showing a Copes-Vulcan control system working at a showcase generating plant.



Precision boiler cleaning with Copes-Vulcan Selective-Sequence or Automatic-Sequential soot blowing systems. Space-saving panel permits easy monitoring, flexible programing . . . assures thorough cleaning with less steam and/or air. Write for Bulletin 1029.



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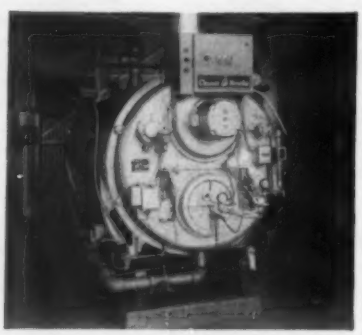

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163 Belt Conveyor Idlers — Forty-pp Book 2716 contains engineering selection data on five new series and 23 types of belt conveyor idlers, emphasizing their application versatility. Lists idlers for belt widths from 14 to 48 in. Book is key indexed for easy reference, as an aid in selecting the exact idlers to match specific belt conveyor operating requirements. Photos and dimensional sketches illustrate descriptive text. Link-Belt Co.

164 Dust Collectors — A wide range of industrial dust and fume producing processes that can be successfully controlled with the properly designed cloth or glass bag-type dust collectors is covered in 24-pp Bulletin 562-D. Operating principles are illustrated and typical applications pictured. Wheelabrator Corp.

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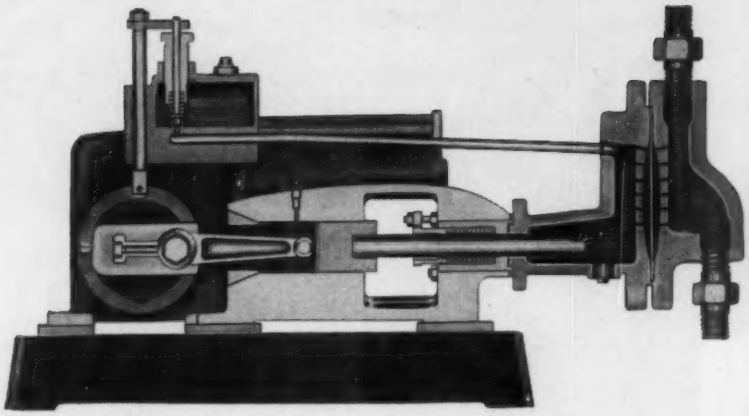

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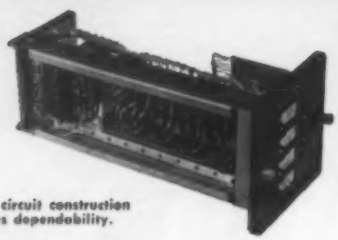

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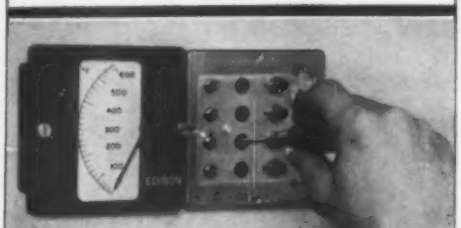

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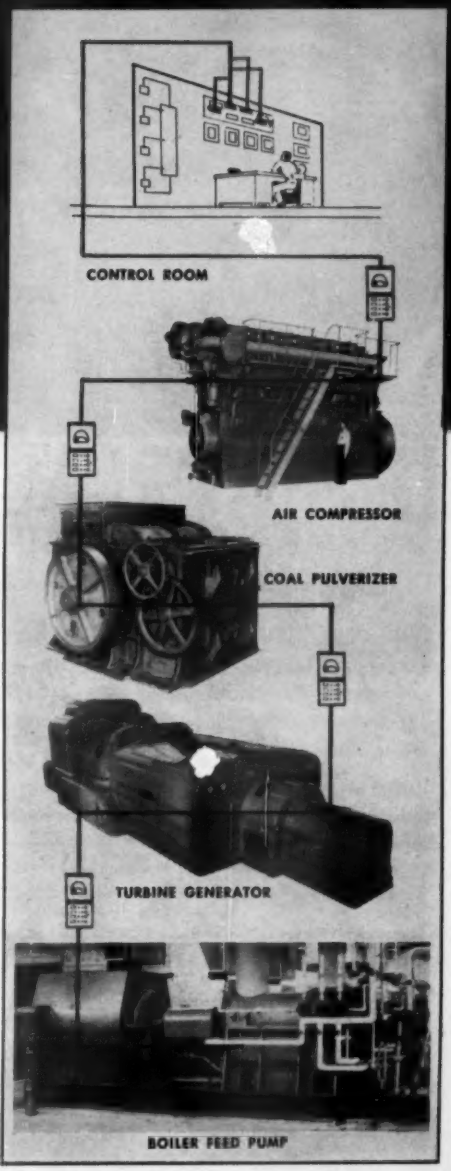

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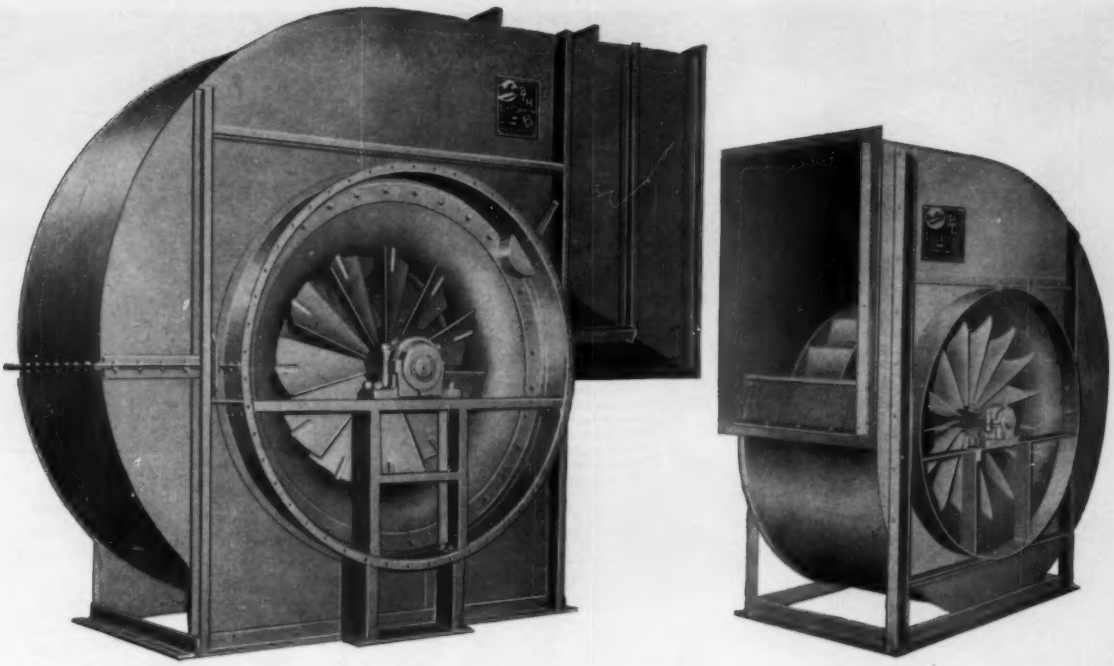

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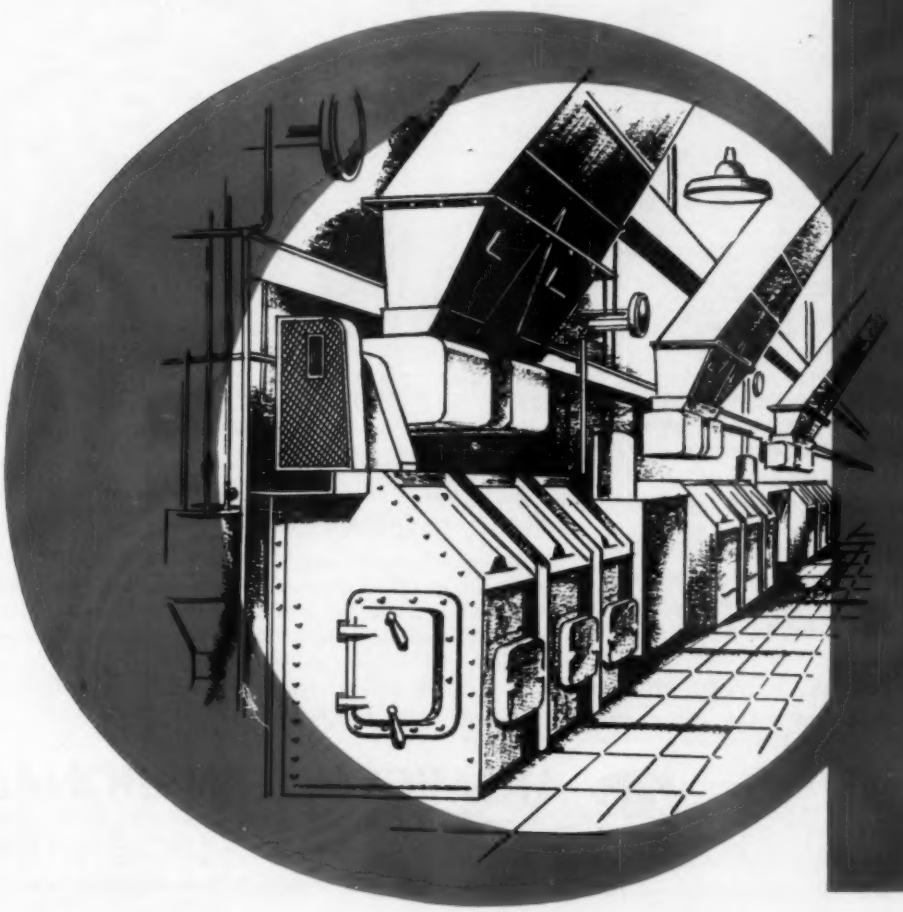

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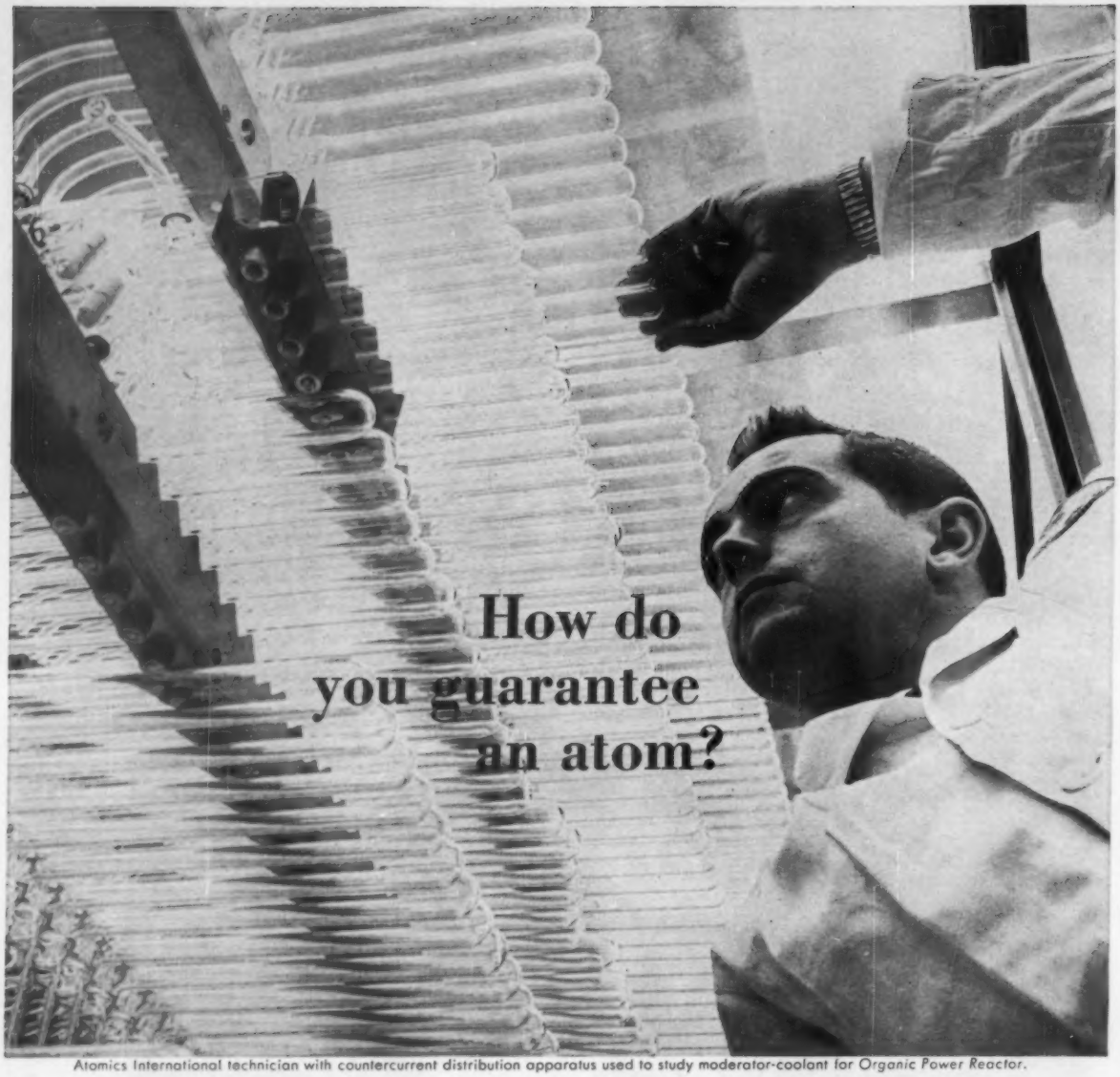

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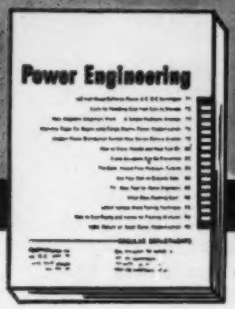

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A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World
Published by Technical Publishing Co.

March 1959

Cerenkov Radiation. Few who have had the opportunity of looking down into a swimming pool type of nuclear reactor have not been fascinated by the blue-green glow of light surrounding the fuel elements. This glow is quite similar to the luminescence of many chemical substances under the action of ultra-violet or gamma radiation, and when it was first observed it was assumed to be just that. Actually, the phenomenon represents something quite different, and while the principle involved is quite simple, it was not easy to discover.

Strangely enough, this Glow which is known as Cerenkov radiation, is involved with one of the most fundamental things in nature -- the velocity of light. It is the result of particles moving with speeds greater than that of light.

Now, if this statement seems strange, you have every right to question it, since it may seem to contradict one of the most inviolate principles of modern physics -- the limiting velocity of light. One of the basic principles of the Einstein theory of relativity is that the velocity of light in vacuo, usually denoted by c, and equal to 300,000 kilometers per second, is a limiting velocity in the sense that no material body, and therefore no particle whatsoever, can ever attain this limit.

The explanation to this apparent anomaly, of course, lies in the words, in vacuo, in the Einstein statement. Light is propagated in vacuo with the limiting velocity c, but the velocity of light in material media, such as glass, water, or air, which we may denote as c', is in general different from c. The value of this velocity depends both on the properties of the medium and on the frequency of the light wave. In many instances the velocity c' is less than the velocity c in vacuo. Therefore, a particle moving in a medium can possess a velocity v which, being smaller than the limiting velocity c, is yet greater than the velocity c' of light in that medium.

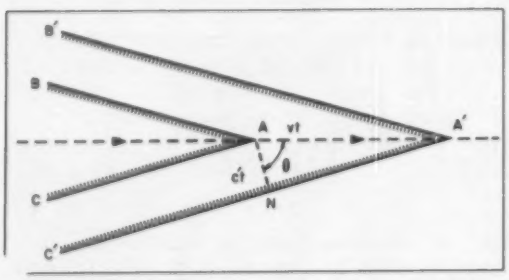
The necessity to discriminate between the velocity of light in vacuo and that in a medium is quite obvious. But a lack of just such discrimination was the cause, historically, of the fact that physicists, during the interval of about 30 years between the establishment of the theory of relativity and Cerenkov's discovery, tacitly assumed that the velocity of a particle greater than that of light is unattainable even if the particle moves, not in vacuo, but in a medium.

In explaining the Cerenkov effect it is interesting to start with a consideration of what happens when an electrically charged particle moving in a medium attains a velocity v greater than the velocity c of light in this medium. First, however, let us look at the mechanism of the radiation of waves in general -- not only light waves but also sound waves in air or waves on the surface of

liquids. In all cases, the radiation of waves is caused by movement of some kind; in the case of electromagnetic waves by the movement of electrons in a radio antenna or in an atom in an excited state. In the case of sound the movement may be a diaphragm or a violin string. If the velocities of these movements are smaller than the velocity of propagation of the waves in question, then by a general rule a uniform, unaccelerated movement of the bodies in question is not accompanied by the emission of any radiation. Under these circumstances only oscillatory movements emit radiation as for example oscillations of electrons representing an alternating current in a radio antenna or the oscillation of a violin string. But if — and only if — the velocity of movement becomes greater than that of the propagation of waves, then a new and important mechanism of radiation sets in. By this mechanism, the radiation is emitted even by unaccelerated movement of material bodies.

The Sonic Barrier. An excellent example of this type of radiation is in the crossing of the sonic barrier by high-speed aircraft. So long as the velocity of the aircraft is less than that of sound in air, the only sound emitted is that produced by the oscillatory motions of the engines and propellers. However, when the speed of the plane exceeds that of sound, even the uniform movement of the machine as a whole produces an additional radiation of very intense sound waves, known as Mach's waves. Since the emission of waves means loss of energy the power of the engines has to be increased considerably to make up for the losses. This is the reason why the sonic barrier is so difficult to cross.

This analogy between the shock waves of supersonic aircraft and Cerenkov's radiation was interestingly explained by Academician I. E. Tamm of the USSR in a lecture at the Geneva Conference last September. It was to Professor Tamm, together with P. A. Cerenkov and I. M. Frank that the Nobel Prize for Physics was awarded for their work in this field. As Academician Tamm pointed out, it was this analogy between the Cerenkov radiation and the sound of a projectile that induced them, originally, to use the term singing electrons for the Cerenkov effect.



In explaining the analogy, Professor Tamm used the accompanying diagram. A supersonic aircraft or a super-light-velocity electron in a medium produces respectively a sound wave or a light wave which is stationary with respect to the aircraft or the electron, as the case may be. This means that if, say, an electron moves, during an interval of time t, from the position A to A' — from left to right in the diagram — then the front of the accompanying Cerenkov wave BAC moves along with the electron without change in the form of the wavefront, from BAC to B'A'C'. While the electron travels from A to A' with a velocity v, the light wave is propagated perpendicularly to the wavefront with a velocity c. Thus AA', the distance traveled by the electron in a time interval t, is equal to vt; and AN, the distance through which the light wave is propagated in the same interval of time is equal to c't. Since c' is less than v, the ratio AN/AA' is less than one, as drawn in the figure; and if we denote by θ the angle between the direction of motion of the electron and the direction of propagation of the light wave, we find that c'/v is equal to the cosine of the angle θ.

Since the cosine of an angle is necessarily less than one, we obtain the results mentioned previously that, for the radiation to be possible, the velocity v of the particle (or projectile) must be greater than the velocity c' of light (or sound) in the medium.

But at the same time we get another result: the radiation is propagated, not in all directions, as in the case of an ordinary light source, but only at a definite angle to the direction of motion of the electron. Only one plane is shown in the diagram, that of the paper. But if we imagine the diagram to be rotated about the line AA', then we can see that radiation is emitted in space along a

conical surface making the same angle θ with the direction of motion. If the electron is stopped after having traversed a certain path, this conical wave will continue to propagate in the medium as a free light wave.

Explained in this way, the whole phenomenon is very simple, but as Dr. Irving Langmuir observed many years ago, it is not always easy to discover simple phenomena, and in this case an uncritical application of the theory of relativity greatly delayed the discovery of this principle. Indeed, its history is extremely interesting. S. I. Vavilov, the noted Soviet physicist, suggested to P. A. Cerenkov, who at that time was a research student, that he should investigate the luminescence of various substances induced by irradiation with gamma rays. Since the substances to be investigated were to be used in solution in water, the first task of Cerenkov was to study the solvent itself — the water, which was supposed to give no luminescence under gamma ray irradiation. Quite unexpectedly, however, he found that even the purest samples of water were very feebly luminescent. The gamma ray sources used by Cerenkov at that time were so weak that he could see the feeble luminescence only in a dark room after prolonged adaptation. Many of the physicists who were shown Cerenkov's experiment were highly sceptical and hinted at visual hallucinations.

Even those who thought that the luminescence was real assumed it to be of the same nature as the well-known luminescence of many chemical substances under gamma ray irradiation — which is caused by the excitation of the molecules of the substance. Indeed, the whole thing seemed to be quite trivial, but Vavilov had a scientific flair and at his suggestion Cerenkov performed some further crucial experiments. Vavilov's role in the work was, in fact, so decisive that in the Soviet Union they call the effect, not Cerenkov's but Vavilov-Cerenkov's.

Having measured the polarization of the luminescence in the water and the changes in intensity caused by heating or by adding to it so-called quenching substances, Cerenkov had found in the year 1934 that in all these respects the behavior was quite different from the behavior of the ordinary luminescence. It was a very peculiar phenomenon. Soon after, I. M. Frank suggested that this peculiar luminescence might be caused, not directly by the gamma rays, but by high-energy electrons produced by the gamma rays in the water. Frank proposed an experiment using magnetic fields to prove his theory. When performed by Cerenkov this experiment not only proved what Frank suggested but led to a further unexpected result, namely, that the fast electrons emit the radiation not uniformly in all directions, but only at rather small angles to the direction of their motion.

Professor Tamm said that this fact led him personally to the conclusion that this radiation must be caused, not by the collisions of the electrons with the molecules of the medium as it is in ordinary luminescence, but by the uniform motion of the electrons in the intervals between these collisions. Working out this idea, Frank and Tamm succeeded in 1937 in constructing a proper theory of this phenomenon. The whole story is just an example of the round-about ways by which an insight into very simple facts is sometimes arrived at, when preconceived ideas have first to be exposed and discarded.

The radiation of light by water irradiated with gamma rays, which was so feeble and difficult to observe in the thirties when Cerenkov had only feeble radioactive sources at his disposal, nowadays literally strikes the eyes of the observer when the primary radiation comes from the fuel elements of a nuclear research reactor, and as pointed out at the beginning of this article, it is one of the fascinating aspects of a swimming pool type of reactor in operation.

Practical Applications. Aside from its intrinsic scientific importance the Cerenkov radiation has proved useful in a number of ways. Perhaps the most straightforward application of the radiation is the Cerenkov counter by means of which fast electrically charged particles can be detected and their velocity measured. The fast particles emit light when traversing transparent substances in which the velocity of the visible light is less than that of the particles in question. As already explained, the light is emitted along a conical surface, and produces an

illuminated ring on a screen or photographic plate. By measuring the radius of this ring one can determine the angle at which the light is emitted, and so the velocity of the particles can be calculated from the relation already mentioned.

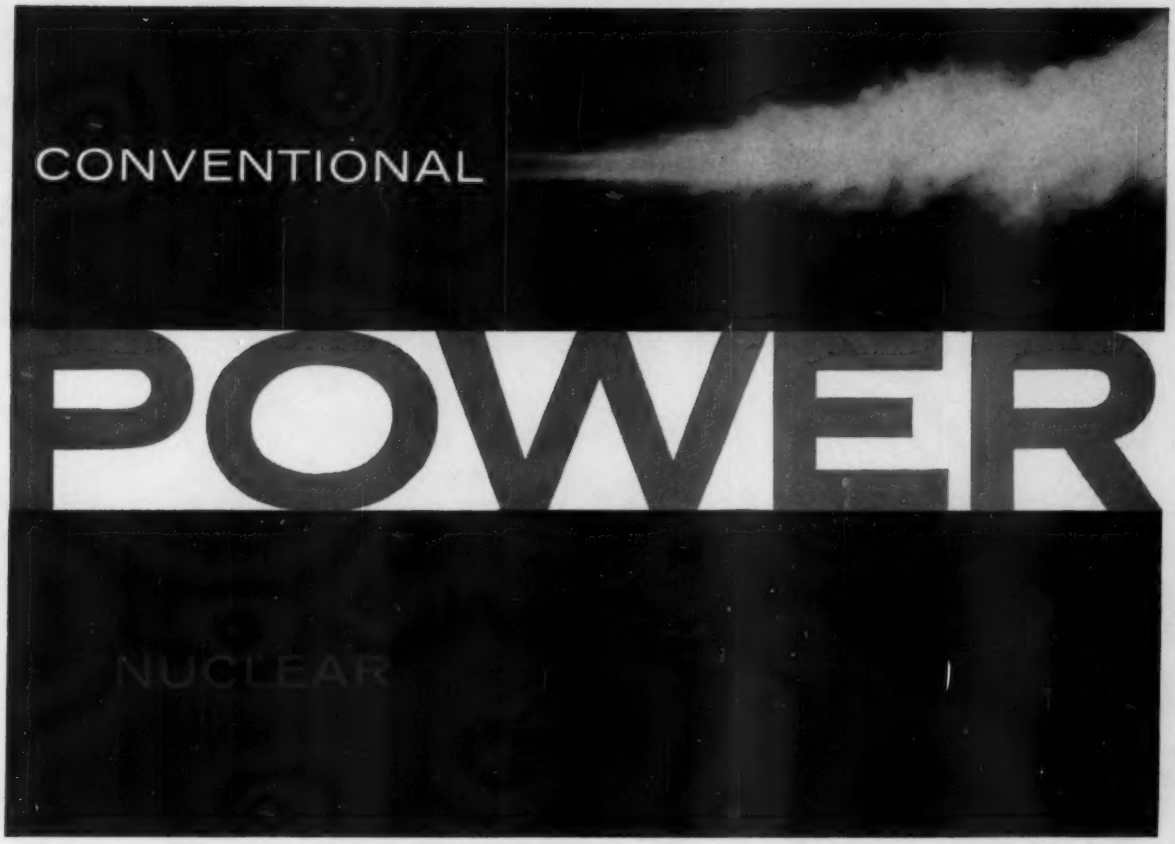
Cerenkov counters are now widely used in research conducted on accelerators. In many respects they have advantages over other kinds of counters. Without going into detail an interesting example of their usefulness in this field is in connection with research on the anti-proton, discovered by Segre, Chamberlain and their co-workers in 1955. A beam of fast particles produced by the California accelerator contained negative charged particles, all of which had the same momentum. The vast majority were pi-mesons, but it was expected that a very small number of anti-protons would also be present in the beam. The problem was to find proof of their existence. For the same momentum, the velocity of the heavy anti-protons should have been equal to about three quarters of the velocity of the lighter pi-mesons. Cerenkov counters were placed in the beam, one of them registering only those particles having the velocity equal to the expected velocity of the anti-protons and not registering the faster mesons. Thus, every output pulse of this counter revealed that an anti-proton had passed through it, although there were 40,000 times fewer of them than there were mesons. Other methods of registering anti-protons were, of course, also used.

These Cerenkov counters are widely used, not only in work with accelerators but also in cosmic ray research. Professor P. M. S. Blackett in England was the first to suggest, in 1949, that the characteristics of the extensive air showers caused by primary cosmic ray particles impinging on the earth's atmosphere from outer space, could be determined by measuring the Cerenkov radiation of the particles from these showers. Although the index of refraction of air for light in the visible spectrum exceeds unity by only 0.03 per cent, the velocity of most of the electrons in cosmic ray showers differs from that of light in vacuo by even a smaller percentage. Therefore, they emit Cerenkov radiation when moving through the atmosphere. Moreover, this radiation is directed almost exactly along the path of the particles in the shower, that is, towards the earth. By focusing this radiation by means of a parabolic mirror, it is possible on a clear moonlight night to record the burst of the Cerenkov radiation from a shower. From the intensity of the burst the energy and some other characteristics of the shower can be evaluated.

The Cerenkov effect can also be used as an artificial source of electromagnetic waves with a wavelength of less than one centimeter. Since generation of such short waves by other methods is very difficult, Cerenkov generators of this kind may prove particularly valuable.

Offhand it might seem that such a generator might be uneconomic because it demands intense beams of very high energy electrons -- in other words, costly accelerators. This, however, is not the case. The velocity of propagation of micro-radio waves in many media is by an order of magnitude less than the velocity of light in vacuo. Therefore these waves are radiated even by electrons moving in such media with an energy of only a few thousand electron-volts. While the use of such slow electrons involves certain difficulties, they can be overcome and at the Moscow University Miss Minakova and Miss Volkova have recently constructed an experimental model of such a microwave generator which produces waves in the 3 to 10 cm band with an output of only a few milliwatts. At present they are engaged in constructing a similar device which will have an output on the order of one watt.

Andrew V. Kramer



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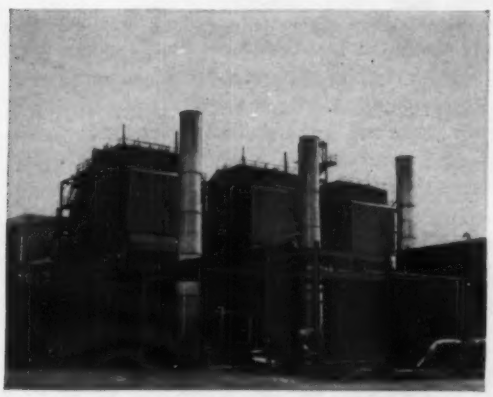

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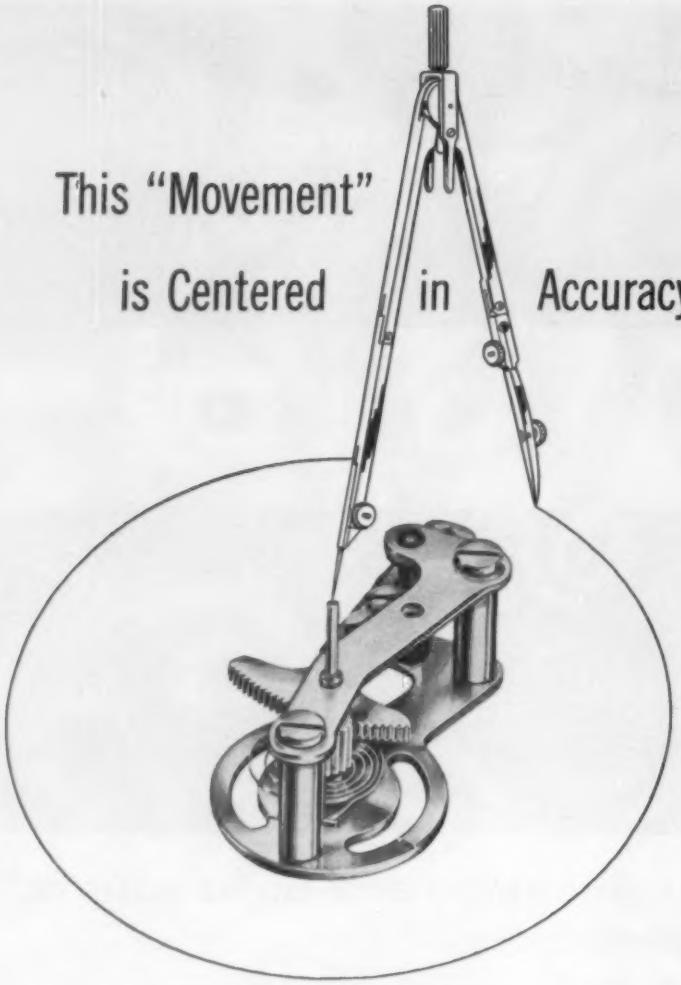

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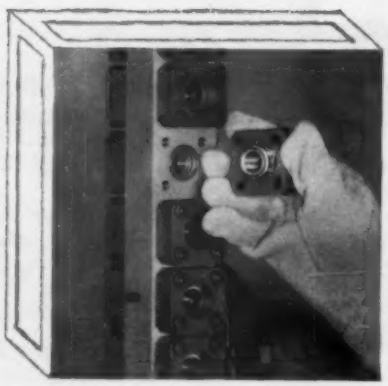
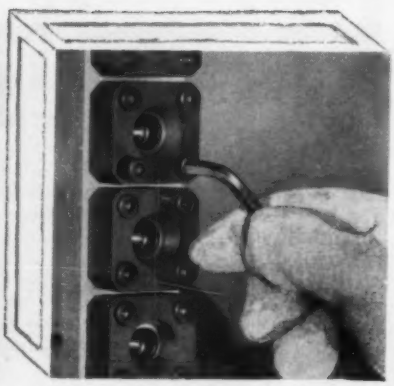


b Re-install complete cover assembly. Sealing gasket automatically seats in gasket groove in body.



c Tighten down four Allen cap screws with standard wrench (no torque wrench required).

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TRACERS

Power Engineering's Monthly Probe of Power Facts

A-c motor which uses d-c excitation to the stator and two-phase a-c voltage to the armature, thus giving smoothly adjustable speed characteristics of a d-c motor and power factor control characteristics of a synchronous motor, has been tested successfully in small experimental size. It was described at a recent AIEE meeting by Prof. Paul K. Charlu of P.S.G. College of Technology, Coimbatore, South India.

Use of mechanical rectifiers for obtaining direct current has been somewhat controversial in this country. Experience of Aluminum Foils, Inc, with the method, set forth on pages 57-58 of this issue, is a strong vote in its favor.

Cable cutter with a non-shorting feature has been developed by Beckman & Whitley, Inc. Use of a ceramic cutter blade which is driven through the cable bundle onto a ceramic anvil prevents short-circuiting of the individual conductors when the cutting action takes place. Driving power comes from a standard screw-in explosive cell.

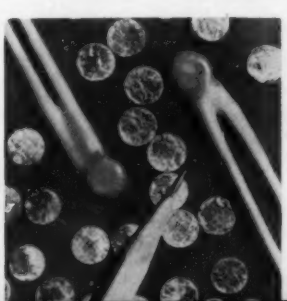
Biggest little turbine is probably the 50-mw steam unit built by Westinghouse for the Detroit Public Lighting Commission. Steam inlet is at 1800 psig, 1050 F, and 1000 F reheat — exceptionally high steam conditions for a turbine of this rating. Six instead of five stages of feedwater heating are used.

Rigid sampling program is needed on all components in a carbon-molybdenum steel piping system operating under h-p h-t conditions. Why? Graphitization, with resulting failures, can occur. Such is the conclusion, out of experience, of the Oak Ridge Gaseous Diffusion Plant power plant. C. H. Mahoney and W. S. Dritt give details, pages 68-69.

Highest subtransmission voltage in use in any North American city is said to be the 230,000 v at Vancouver, B. C. First stage of the 230-kv subtransmission network was energized late in 1957 and involved 14 miles of underground oil-filled cables as well as two major distribution substations.

First transistor tester capable of checking the performance of transistors while they are connected within their circuits is being produced by Philco Corp. In-circuit testing saves trouble-shooting and servicing time without turning on power in the equipment.

Ground has been broken for construction of Sheldon Station and Hallam Nuclear Power Facility of Consumers Public Power District, Columbus, Neb. The Hallam plant is the nation's first publicly-owned commercial atomic plant. It will include a 75,000-kw reactor, is planned for completion in late 1961.



Westinghouse has developed and begun to apply a solid state device that acts as a temperature-sensitive switch. When the temperature of this device is below a certain critical value, it functions as a closed switch. When temperature is above this value, it functions as an open switch. Tiny metallized ceramic discs are at the heart of each of these "thermistors." The device meets the need for a system for over-temperature protection of hermetic motors in large air conditioning and refrigerating systems.

How the U. S. Trains Military

Fig. 1. Students use scalers in the chemistry and physics laboratory to measure activity of radioactive sources

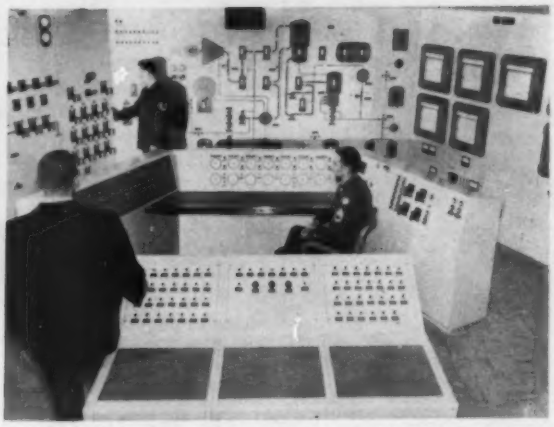


Fig. 2. Trainees manipulate controls on the APPR simulator as instructor sets up practice problems from his console

By WILLIAM R. WRAY, Major, CE *

A NEW SCHOOL has been set up and is now in operation at Fort Belvoir, Virginia, to train personnel of the Army, Navy and Air Force to operate nuclear power plants at remote installations. Fort Belvoir is the site of the Army Package Power Reactor (APPR-1), a prototype nuclear power plant of 2000-kw capacity. The school is operated by the Army Corps of Engineers acting in its role as the Department of Defense agency which is developing, jointly with the Atomic Energy Commission, a family of ground nuclear power plants for the use of all three services. This article describes the course which is given, the philosophy behind it, and how it is taught.

Before discussing details of the course, it is appropriate to point out several factors which were considered in setting up the program of instruction for the school. Important among these factors were the experience and qualifications of incoming students, the nature of service requirements and enlistment periods, the varied types of field plants which may be constructed in the future, and the type and size of crews which will operate those field plants.

A study of the above factors led to the adoption of three major requirements to be met by the training. These requirements dictated the scope and character of the present course and the type of personnel to be selected for training. They were:

1. Operators should be prepared to serve in plants using different types of reactors. Although the APPR-1 uses a pressurized water reactor, other plants just completed, under construction and under development for the future, utilize boiling water reactors, gas-cooled reactors, and possibly others. Since the men being trained now may go to plants using any one of these reactor types, their training should be broad enough to prepare them for the varied assignments.

2. Operators should be capable of rapidly qualifying for supervisory positions. The men being trained today will form the core of experienced personnel who will be tomorrow's shift supervisors and potential plant superintendents. This also indicates the need for a broad and comprehensive training program. In addition, it necessitates the selection of highly capable individuals for training.

3. Plant personnel should be dually qualified. In order to achieve minimum crew sizes for remote plants and still maintain maximum flexibility within the crew, it has been decided, at least tentatively, to train all members of the crew in both operation and one of four skills — laboratory work (covering chemistry and health physics), or mechanical, electrical, or instrument maintenance. A typical crew for a fixed plant is expected to be similar to the following: 1 — officer-in-charge; 1 — superintendent; 4 — chief operators (shift supervisors); 4 — operators; 1 — maintenance supervisor; 4 — maintenance technicians; 2 — laboratory technicians.

Absences due to sickness or vacation from among the operator positions would be covered by maintenance personnel since they are also qualified operators. The crew members at any plant would be selected to provide a suitable distribution of the maintenance skills required.

Since the successful achievement of the above goals is highly dependent on the quality of the men to be trained, great care is taken in their selection. Personnel are chosen from among a large number of volunteers who meet rather rigid standards. Applicants for training must have had experience in one of the four skill areas mentioned above, preferably working with equipment similar to that found in steam power plants. Although it is desirable to specify steam power plant experience, the Army and Air Force possess very few career personnel who have had that type of experience.

All applicants for the training must have attained scores above 115 on the Army General, Electrical and Mechanical Aptitude Tests. This requirement compares with approximately the same score one must achieve to be considered for Officer Candidate School and is some 15 points higher than the average score attained Army-wide.

Prospective students must have completed high school and have credit for a course in algebra. In addition to the mental and experience requirements, the applicants must be mature, responsible individuals who have better than average records, are highly recommended by their commanding officers, and show a strong desire to enter the program. After comparing records of the applicants and carrying out interviews, the school staff selects the top prospects for training. The class presently in the school consists of the top ten per cent of the applicants.

After selection for the course and prior to reporting to the school all

* Chief, Nuclear Power Field Office, U. S. Army Engineer Research and Development Laboratories, Fort Belvoir, Virginia

Nuclear Power Plant Operators

Inside the APPR-1 at Fort Belvoir

Fig. 3. Contamination control point near entrance to APPR vapor container. Reactor is pressurized water type

Fig. 4. APPR–1 is a prototype nuclear power plant of 2000-kw capacity. Training here serves a family of ground nuclear plants for all three services

Figs. 5 and 6. Crew member lowers fuel element through water to reactor core using long handling tool. Fig. 6 shows element partially inserted in core

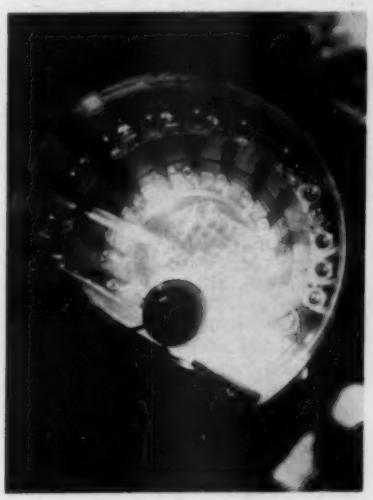
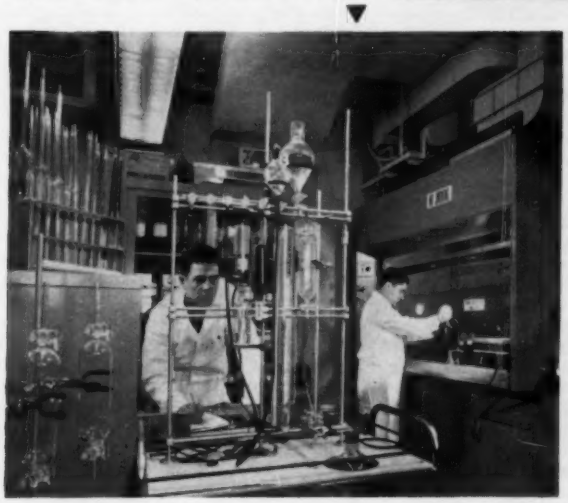
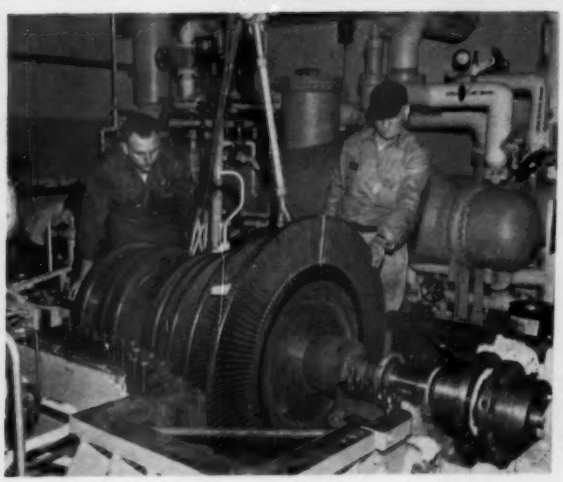


Fig. 7. Health physicist and chemist at work in APPR Laboratory. Fig. 8 shows inspection of turbine after first eight months of operation in APPR ▼





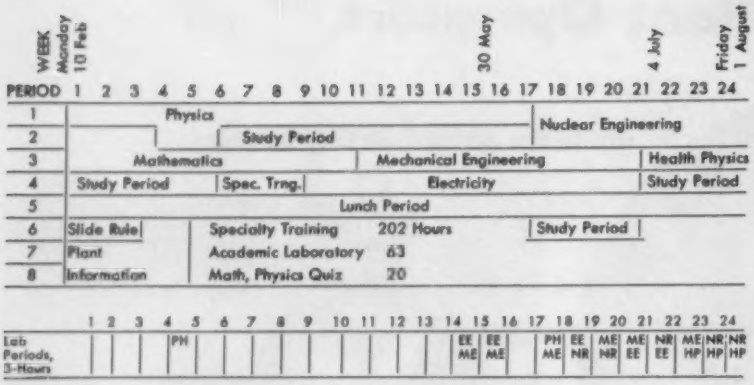


Fig. 9. Typical schedule of academic phase of nuclear power operator's course

prospective students are sent copies of a mathematics workbook which contains a series of progressively difficult exercises to be worked out. These exercises are completed and submitted to the school on a regular schedule, graded by members of the school staff, and returned to the students with correct solutions.

This preparation for the course gives the men a review of simple math, helps them regain number facility, and places them in an academic frame of mind. In addition, this work enhances the progress of the academic course work by placing all students on more of an equal basis at the beginning of their training.

The one-year training period is broken into two major parts — an academic phase and an operations phase — each of about six months.

Academic phase is designed to ground the students in the basic sciences involved in nuclear power plants and is taught on both a technician level and an engineer level. Engineer-level course is primarily for officers and presumes an engineering or science degree as a prerequisite to the graduate level work in advanced math, nuclear physics, mechanical and electrical engineering. Remainder of this discussion pertains only to the technician level instruction.

Technician Training

Curriculum for the academic phase includes: math (80 hours) including algebra, trigonometry and an introduction to calculus; physics (105 hours) including mechanics, electricity and magnetism, heat transfer and nuclear physics; nuclear engineering (90 hours) covering practical aspects of reactor components and operation; basic mechanical engineering (68 hours) with emphasis on the thermodynamics of steam cycles; basic electrical engineering (75 hours); health physics (29 hours); power plant systems and components (50 hours); and specialty training (200 hours).

Specialty training is set up to extend the students' skills in one of the three maintenance fields or the chemistry and health physics field. Typical schedule, shown in Fig. 9, indicates that the systems and components instruction and specialty training are spread throughout the academic phase. This minimizes the number of hours of intensive academic work per day and serves to relate the classroom instruction to its practical application.

Operations Phase

Operations phase of the course is almost entirely practical work and might be divided roughly into four major categories: plant systems and operating procedures (120 hours); training on an electronic simulator (200 hours); operating experience in the APPR-1 (420 hours); and additional specialty training (200 hours). With the exception of some classroom work which is required in the teaching of operating procedures, instruction is the type requiring student performance under close instructor supervision and guidance. The last several weeks of the operations phase are devoted to qualifications testing. This testing consists of written, oral, and performance examinations with emphasis on the performance type.

Typical class of 40 students is broken into sections of 20 for classroom work, approximately 10 for laboratory work, and to crews of 3 for work on the APPR-1 simulator and in the APPR-1 itself. Faculty consists almost entirely of officers and enlisted personnel (from all three services) who have successfully completed a similar course and have qualified as operators on the APPR-1. A few contract civilian instructors are used to supplement the staff, serving mainly to advise and instruct the students during their in-plant training.

Training facilities are the finest available for teaching such a course. Maximum use is made of visual aids, laboratory equipment, models and mockups, and duplicate plant hardware to facilitate learning. Obviously no training is better than actual experience in the plant itself, and many hours are devoted to just that, with trainees being rotated among the various operating and maintenance positions. There are, however, limitations to this plant training.

Although much time is devoted to the training mission, the APPR must be used to advance research and development and to gain valuable operating experience and data. This precludes starting up and shutting down the plant as often as one might desire for training and also limits the practice of other procedures. In order to minimize this problem a nuclear power plant simulator (see Fig. 2) is used for teaching all procedures which are performed in the control room of the APPR-1.

The simulator is almost identical with the APPR-1 control room equipment and includes an instructor's console and an analog computer. The computer is set up with the APPR equations so that any actions on the part of the operator will give the same instrument indications which would be displayed in the APPR under the same circumstances. The simulator is used 24 hours a day in teaching reactor operation; startup, shutdown, and routine operating procedures required of the control room operator; synchronizing with another power supply; and emergency procedures.

In addition to the above, the loading of a new core in the reactor can be simulated and numerous experiments can be carried out to give the operators a better understanding of nuclear aspects of plant operation such as control rod worth, Xenon buildup, core burnup, temperature coefficient, etc.

Even with all the special devices used in the school, the course is very demanding and intensive. The present group of students would be the first to admit this. In fact many people have stated that this is certainly one of the toughest courses given to enlisted personnel in the services.

The class that started in February, 1958 was the first one to receive this integrated program of instruction entirely at Fort Belvoir. Although experience has shown the course to be basically sound there are a number of changes which have been made to improve the course for the January, 1959 class. In general these changes are minor and will serve to put across the instruction in a more effective manner.

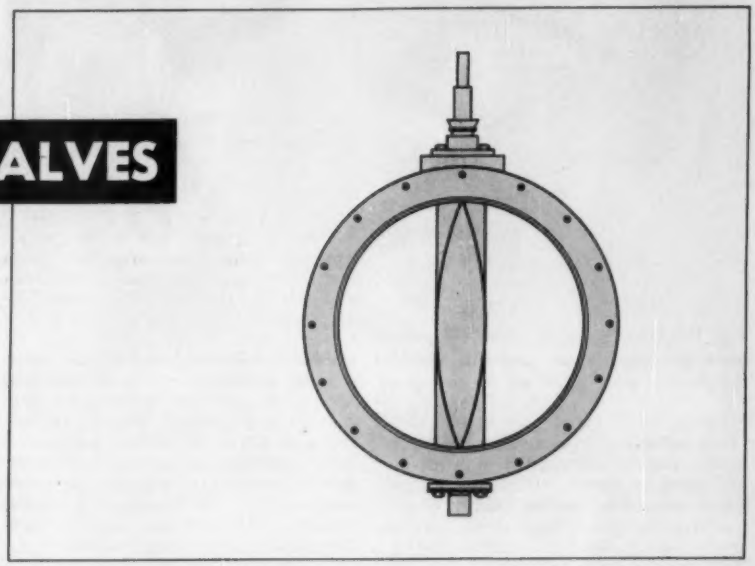
For The Future

Present planning envisions shortening certain portions of the course, particularly the academics, at some later date and possibly shifting to two courses at different levels. Under this plan a man would take a shorter operator level course and then serve as an operator in a field plant for several years. If he showed the proper qualities and capabilities he would return to the school for a short supervisory level course. THE END

Power Engineers' Valve Manual . . . .

This final article, in the series of basic valves used in the power field, deals with Butterfly valves. Previous articles dealt with Plug, Gate, Check, Blow-Off, Diaphragm and Globe types, plus valve operators. The complete Valve Manual will be available immediately. Write for yours

BUTTERFLY VALVES



By ABDON J. BRAZAITIS
Sales Engineer
Henry Pratt Company
Chicago, Ill.

Chicago born and educated, Abdon Brazaitis graduated from the Illinois Institute of Technology as a mechanical engineer. He joined the Henry Pratt Company in 1950 as a design engineer, and spent some five years in the Engineering Department working on the design of butterfly valves and related equipment.

In 1955 he was assigned to head the newly established Application Engineering Department. His work has gradually led him away from the so-called "standard" valve applications until, at present, he is involved almost solely in application engineering on special valve problems.

Mr. Brazaitis is a Registered Professional Engineer in the State of Illinois, a member of the American Society of Mechanical Engineers and the Western Society of Engineers.

BUTTERFLY VALVES are one of the oldest practical devices for controlling the flow of fluids. They had their beginnings in light weight, non-tight applications such as dampers. Partly because of this early history of light weight construction, and also because of a lack of adequate flow data, engineers were, for a long time, reluctant to specify butterfly valves in industrial applications. The development of a leak-tight, workable rubber seat, however, gave considerable impetus to the industrial use of the valve, and experience with it soon overcame the early objections.

The first rubber seat butterfly valve was designed by the late William H. Phillips, and manufactured by the Henry Pratt Co in 1926. This valve found immediate and widespread acceptance in the power industry, the first major industry to make extensive use of it.

As the size of central station equipment increased, with mushrooming power demands, condenser circulating water pipe also increased in size, bringing problems in specification of large diameter valving. By specifying the butterfly valve, power engineers secured the advantage of a compact, light weight valve which does not require the use of any supports other than those required by the pipeline itself.

An additional advantage is that natural gum rubber has an excellent "memory," in that it resists permanent indentation. With the natural preservative action of water, the valve seat life greatly exceeds that of any other valve type. One rubber seat butterfly valve, on a test installation, was cycled every 20 minutes for a period of about three years, until a total of 80,000 cycles was accumulated. When returned to the shop, this valve tested bubble-tight.

Function in Power Plants

There are a number of important applications for butterfly valves in modern power plant. One of the main applications is in the condenser backwash systems which provide periodic cleansing of the tube sheets. Some plants employ only partial backwash systems, but the newest have total systems which permit backwashing the condenser without loss of condenser vacuum, and with only a momentary drop in generating capacity. Butterfly valves find their widest power plant usage in these condenser flow-reversing systems.

In connection with reversing systems, we might briefly mention the successful development of the Butterfly Reversing Valve, which can be

Fig. 1. Typical butterfly valve, cut away to show body, shaft and disc design

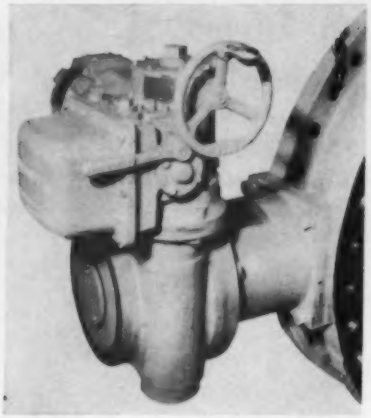


Fig. 2. Conventional electric motor operator mounted on valve. Note indicator

Fig. 3. Manual valve operator, which employs handwheel and reduction gear

likened to a giant four-way valve. This valve employs an elliptical butterfly disc to accomplish flow reversal, and is sometimes better suited than are several round valves.

Over the years, dozens of systems have been developed for interlocking, sequencing and actuating butterfly flow-reversing systems. The optimum recommendation can only be made after the valve manufacturer has made a detailed analysis of the hydraulic characteristics of the circulating-water system.

Butterfly valves also find wide use as pump discharge valves, either for sectionalizing service when a number of pumps are connected into a common header, or as emergency closures to prevent flow-reversal in the event a pump goes out of service. Butterfly valves in pump discharge service can be synchronized with pump operation, so they will open as the pump starts; or, the pumps may be set to start operating at any point in the valve opening cycle.

Valves can be installed "fail-safe," so that in the event of pump or power failure, the butterfly valve will close in a specified time. In the case where long lengths of pipeline are involved, a two-speed operator may be required. This type of operator allows the butterfly valve to close, for the major part of its travel, at a fairly fast speed, while the last portion of travel takes place at a considerably reduced speed. This avoids line shock pressures, while minimizing the water lost back to sump. The choice of the two closing speeds, and the exact transition point, is a function of the hydraulics of the system, and should be analyzed by the valve manufacturer for each specific application.

Uses for butterfly valves, other than the aforementioned, are being discovered as power plant technology and design philosophy advance. As an example, with the advent of nuclear power, a new application required the development of the quick-closing butterfly valve. These are used on the air ventilation systems of reactor containment vessels. In normal operation the valves are in the open position, allowing air to circulate through the containment vessel. However, in the event of a reactor incident, these valves must immediately close to maintain safety.

Valve Specifications

Most circulating water valving is designed to a 50 psi standard. Rubber-seat butterfly valves in this pressure class will provide drop-tight shutoff at 50 psi, and will withstand 70 psi shock pressures. This class of valve is suitable for both circulating-water service and most pump discharge application; however, where required, valves in a 125 psi class are available. These valves are drop-tight at 125 psi, and suitable for the most rigorous application.

Since power plant circulating water piping is of fabricated steel, a typical butterfly valve specification would be as follows:

Body	Fabricated Steel (ASTM A7)
Disc	Fab. Steel (ASTM A7) w/stainless steel seating edge
Shaft	18–8, Type 304 stainless steel
Bearings	Silicone lubricated bronze
Seat	Natural Gum Rubber Compound
Taper Pins	18–8 stainless steel
Retaining Segments	Nickel Cast Iron

(See Fig. 1 for example.)

Rubber-seat butterfly valves are manufactured in a wide range of sizes, from 4 inch diameter to 11 feet in diameter, and more. However, these represent extremes in sizing, and power plant valves are usually found in a range from 8 to 60 inches, with a few large plants using valves up to 84 inches in diameter.

Power plants in coastal areas are frequently located close enough to the ocean to use it as a source of cooling water. For these applications, salt water corrosion is a special problem. For the ultimate in corrosion resistance, a valve can be fabricated entirely of monel, but the cost of such construction is quite high, and seldom can be justified. Two suitable and economical alternates are tabulated in the Table.

Alternate No. 1 covers a material specification which has many years of proven service. The bronze and monel material combinations are traditionally the materials chosen for salt water service due to their reliability. Since the keeper segments, and rubber seat, cover the inside surface of the body, the cast iron material specification has proven ideally suited to salt water from the standpoint of corrosion resistance and economy of initial cost.

Alternate No. 2 takes advantage of the newer and more economical materials developed in past years. The Ni-Resist and 18–8 Type 304 stainless steel combinations are being more extensively used as the test of time indicates their reliability.

Selecting the Valve Operator

There are three operator types generally used on butterfly valves in power plants. These are: (1) manual gear reducer; (2) electric motor; and (3) hydraulic cylinder. The most popular of these operators is the electric motor (Fig. 2), because its operating requirements are a product of the plant itself. Beyond this obvious fact, however, the push-button control requirements of the modern generating station require an operator which can be remotely controlled, and which is reliable and essentially maintenance-free.

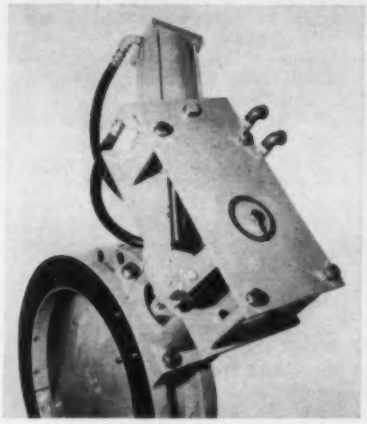


Fig. 4. Hydraulic cylinder operator. This type gives wide flexibility in use

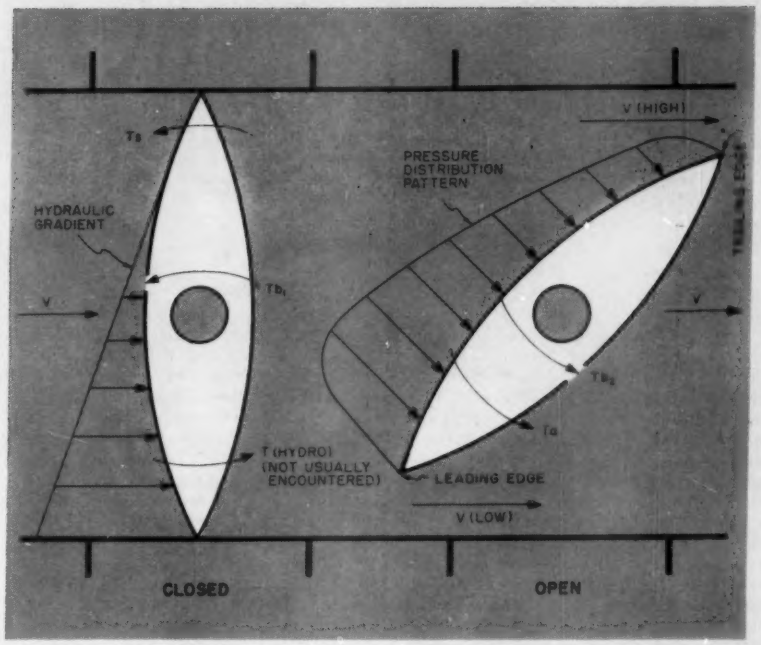


Fig. 5. Illustration of pressure distribution patterns, on valve disc; closed and open positions. Theory of operation might be compared to the lift of airplane wings

The electric motor operator satisfies all of these requirements. The operator consists of an electric motor, coupled through a worm gear assembly which is spline-connected to the valve shaft. Integral limit switches are available for interlocking, sequence operation, and position indication. A torque switch in the motor circuit prevents operator damage, by shutting off the motor if the valve disc meets with an obstruction. Operators may be equipped with remote position indicators and a variety of other equipment to meet specific requirements.

Manual gear-reduction operators (Fig. 3) are used mainly in plants which do not employ automatic backwash systems. Supplied with handwheel or chainwheel, the operator provides great mechanical advantage, allowing one-man operation of even very large valves.

Hydraulic cylinder operators (Fig. 4) are finding increasing usage in modern power plants. Available in a wide range of sizes, the cylinder operator offers considerable flexibility of selection to meet a particular application. For maximum economy, hydraulic cylinders operating in the range of 1000–2000 psi are usually specified. Where a number of valves are involved, a common hydraulic system may be employed, using a single source of high pressure oil. For single valves, or where their installation is otherwise desirable, self-contained "power packages" are available. These units include the hydraulic cylinder, pump, motor, oil reservoir, and all related valves and controls, mounted together on the butterfly valve.

Operator Sizing

A great deal of technical information has been published in recent years, describing the design of butterfly valves. The principal valve manufacturers have printed tables and charts which permit the selection of properly sized operators when flow and pressure conditions are known, eliminating the need for complete evaluation of each application. However, an explanation of some of these design considerations can be extremely helpful in understanding the butterfly valve, in applying it properly, and in specifying it wisely.

The butterfly valve is basically a simple device, but since the configuration of the valve disc (relative to the flowing stream during the opening cycle) is different from other valve types, the forces encountered will vary. Referring to Fig. 5, we see all of the torques represented, and the relative sequence in which they occur. The torques shown are T_h (hydrostatic unbalance), T_s (seating torque), T_{b1} (bearing friction torque, valve closed), T_a (fluidynamic torque) and T_{b2} (bearing friction torque under flow conditions).

Hydrostatic unbalance torque, T_h, exists only when a large valve, in water service, is mounted in a horizontal pipeline with its shaft horizontal, and the pipeline downstream of the valve is empty, while the upstream pipeline is full. This torque is the result of the hydraulic gradient from top to bottom of the full pipeline, producing an off-center action on the valve disc, with resultant unbalanced torque. This unbalance is given by the formula: $T_h = \frac{d^4}{565}$,

where: —

T_h = hydrostatic unbalance; lb.-ins.
d = valve diameter; ins.

For the hydrostatic unbalance to be of any concern, the valve must be of large diameter, must open into a dry system, and must be mounted with the shaft horizontal. The likelihood of all three of these conditions occurring at the same time is rare, and the effects of hydrostatic unbalance need not be considered in this discussion.

The seating torque, T_s, as its name implies, is the torque required to rotate the valve disc into, and out of, the rubber seat. Its magnitude depends only on valve diameter and the seat material, and is a constant function for any particular valve design. The bearing friction torque, T_b, is the frictional resistance to rotation imposed on the valve shaft by the bearings. Fig. 5 shows the valve in the closed position where the bearing friction torque, T_{b1}, is a function of the differential pressure across the valve disc, the disc area, the valve shaft radius, and the coefficient of friction between the valve shaft and bearings. The torque required to open the closed valve, shown in Fig. 5, then becomes the sum of the seating torque, T_s and the bearing friction torque, T_{b1}.

As the butterfly valve disc is rotated in the opening direction, a new force is encountered. This is known as the *fluidynamic torque*, and is shown as T_a in Fig. 5. This torque can be likened to the "lift" experienced by an airplane wing exposed to an airstream. Another good way of describing this phenomenon is the Bernoulli analogy which states, very generally, that *a region of low velocity is a region of high pressure* and, conversely, *a region of high velocity is a region of low pressure*. Referring to Fig. 5, it is seen that the trailing edge of the disc forms a nozzle-like configuration with the valve body, whereas the

Table showing two typical specifications for butterfly valves in salt-water use

	Alternate 1	Alternate 2
Body	Cast Iron (ASTM A126 Class B)	Cast Iron (ASTM A126 Class B)
Disc	Bronze (Composition G)	Ni-Resist Type 1
Shaft	Monel	Stainless Steel, 18-8 Type 316
Bearings	Silicone lubricated bronze	Silicone lubricated bronze
Seat	Natural gum rubber compound	Natural gum rubber compound
Taper Pins	K Monel	Stainless steel, 18-8 Type 316
Retaining Segments	Bronze (Composition G)	Ni-Resist Type 1

leading edge forms a rather orifice-like configuration with the valve body.

Logic dictates that the trailing edge opening would become the region of high velocity, and the leading edge opening one of low velocity. The resultant pressure distribution pattern, in Fig. 5, shows a pronounced unbalance on one side of the valve shaft which, when summed up about the centerline of the valve shaft, results in the fluidynamic torque, T_a, tending to close the valve. Reversing the flow through the valve will still create a fluidynamic torque acting to close it, since the positions of the leading edge and trailing edge have simply been reversed, and the resulting pressure distribution is unbalanced in the same way.

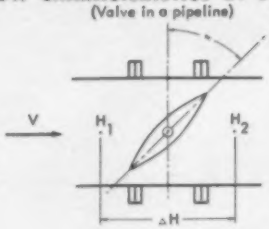
The magnitude of the fluidynamic torque is dependent on a mathematical relationship between the valve diameter, flow velocity, angle of the valve disc, and pressure distribution across the valve. Its peak usually occurs between disc angles of 30 and 80 degrees. Equations developed from experimental flow data enable the prediction of this torque quite accurately. The bearing friction torque, T_{b2}, is distinguished from the torque, T_{b1}, because it varies throughout the opening cycle of the valve as the pressure drop varies with valve disc angle.

Fluidynamic torque, T_a, and the bearing friction torque, T_{b2}, are additive for the opening of the valve. As the valve is being closed, however, the bearing friction torque, T_{b2}, subtracts from T_a, since the bearing friction torque reverses algebraic sign as the direction of shaft is reversed.

Once all of these torque values have been established, the operator sizing becomes a relatively simple matter. The fluidynamic torque, plus bearing friction torque (open), $(T_a + T_{b2})$, are calculated for various valve angles, and the peak value determined. This peak value is then compared with the seating torque, plus bearing friction torque (closed), $(T_a + T_{b1})$. The larger of the values of $(T_a + T_{b2})$ or $(T_a + T_{b1})$ governs the choice of operator size.

Fig. 5. Formulae for determining water flow characteristics in butterfly valves

WATER FLOW CHARACTERISTICS OF BUTTERFLY VALVES
(Valve in a pipeline)



EQUATIONS

$$Q = 2825\, C_f D^2 \sqrt{\Delta H} \quad ; \quad V = 8.01\, C_f \sqrt{\Delta H_f} \qquad \Delta H = K\frac{V^2}{2g} \quad , \text{ or } V = \sqrt{\frac{2g\,\Delta H}{K}}$$

Q = GALLONS/MIN.
C_f = FLOW COEFFICIENT
D = VALVE DIAMETER; FT.
ΔH = HEAD LOSS ACROSS VALVE; FT. OF WATER
V = LINE VELOCITY; FT./SEC.
K = HEAD LOSS FACTOR IN TERMS OF VELOCITY HEAD
g = GRAVITATIONAL CONSTANT 32.17 FT./SEC.^{2}

VALUES OF C_f & K

C_f	K	Valve Angle--	C_f	K
0	inf.	0°	0	inf.
.032	976	10°	.032	976
.079	160	20°	.079	160
.108	85.7	25°	.108	85.7
.142	49.6	30°	.142	49.6
.176	32.3	35°	.176	32.3
.215	21.6	40°	.215	21.6
.276	13.1	45°	.276	13.1
.381	6.89	50°	.381	6.89
.504	3.94	55°	.504	3.94
.646	2.40	60°	.646	2.40
.816	1.50	65°	.816	1.50
1.011	0.978	70°	1.011	0.978
1.247	0.644	75°	1.247	0.644
1.542	0.420	80°	1.420	0.496
1.838	0.296	85°	1.550	0.416
1.950	0.263	90°	1.580	0.400

Flow Characteristics of Valve

Butterfly valves, in addition to serving as shutoffs, can also be used for throttling applications. An index of the excellent throttling characteristics of the butterfly valve is the fact that it has a control rangeability of 45 to 1. A rubber-seat butterfly valve can be used for throttling service and, when required, can be moved to the full closed position to give tight shutoff.

In Fig. 6 there is a tabulation of the flow coefficients, C_f, and corresponding head loss K-factors, for valve angles from full closed to full open position. The left columns cover flow coefficients and head loss factors for a 50 psi design valve, while the right columns cover the 125 psi construction. The heavier disc construction of the 125 psi valve reflects itself in the higher head loss coefficients, for valve angles 80 to 90 degrees.

It is interesting to note that up through the angle of 75 degrees, the loss coefficients for both the low-pressure and high-pressure construction are identical. This results from the fact that up to this point the head loss coefficient is a function of the valve disc angle only. From about 75 degrees, to the full open position, the disc thickness becomes the controlling factor, as the leading edge of the disc begins to swing into the "shadow" of the disc thickness. Since the high-pressure valve disc is thicker than the low pressure disc, the corresponding head loss factors in this range are higher. In addition to these coefficients, Fig. 6 has various formulas for flow, velocity, and head loss for use with the coefficients.

Summary

This brief outline indicates the scope of butterfly valve equipment, operators, controls and control arrangements that are available for power plant use. In order to obtain equipment recommendations which will yield optimum results in service, it is advisable to contact one of the number of reputable valve manufacturers in this field. Using the wealth of technical data validated by years of practical experience, the valve manufacturer can solve valving problems, provided he has a thorough knowledge of the application involved. The valve manufacturer can supply the experience, but information about the application can come only from the power engineer. THE END

Fig. 1. Shown here are d-c power breakers; two for each line. Basic load resistors are mounted on wall behind breakers

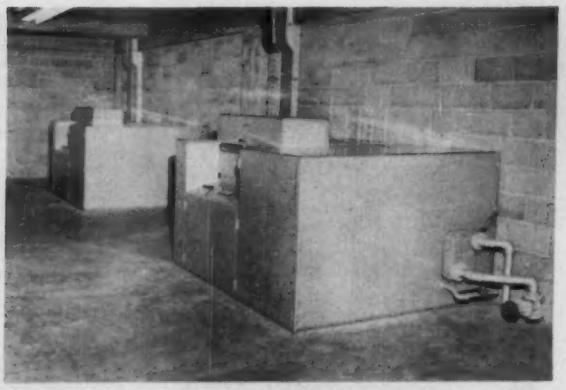


Fig. 2. This photo shows two 4000 kw mechanical rectifiers, entirely metal-clad, and equipped with inspection windows

Operating Experience With Mechanical Rectifiers

This article gives the operating experience of one user of mechanical rectifiers, in the aluminum refinery field. While this method of obtaining direct-current has been somewhat controversial, this plant has had excellent results — in both operation and maintenance

By P. U. FISCHER and H. WIDMER

Since the spring of 1957, Aluminum Foils, Inc., Jackson, Tenn, has operated an electrolytic refinery which serves to produce super-purity aluminum of a grade up to 99.997 percent (Raffinal). It is the first installation of its kind in the United States.

This 20,000-amp cell-line represents a typical example of a direct-current consumer of high current rating, and relatively low voltage. At present about 60 v only, of the rated 200-v capacity, is being utilized.

For the supply of the cell-line with direct current, a contact-rectifier plant has been installed. Deciding factor in this selection has been its high-efficiency at low voltages. In view of the great damage which is caused by the "freezing" of the electrolytic cell-line, if the current supply fails for several hours, ac supply (and conversion equipment), for the full capacity, are available in duplicate.

For the conversion of ac into dc, the contact-rectifiers are using a set of mechanically-driven contacts, which open and close with the frequency of the ac supply. Opening of the contacts has to take place entirely without current, as otherwise material transfer (on the contact surfaces), and sparking, would take place. In order to enable current-free contact opening, the purely sine-wave zero-current passage is being artificially prolonged by the so-called commutating reactors, and the remaining *rest-current* of some few amperes is conducted over a parallel path of the contact. (This equipment uses a thyratron).

Protection of the contact-rectifier is afforded with ac and dc circuit-breakers, and with short-circuiting switches, for the working contacts. In case of a fault, the short-circuiters operate first (closing time of approximately 3 ms only), and prevent the high reverse-current from damaging the contacts. The somewhat slower ac and dc breakers will then follow and clear the fault.

Voltage and current control, respectively, are accomplished by an on-load tap-changing switch connected to the primary winding of the rectifier transformer. This stepwise control is supplemented by a stepless high-speed control, similar to the phase-shift control of the mercury-arc rectifiers. The closing delay is obtained by premagnetization of the commutating reactor. The plant in Jackson is automatically regulated for constant current.

Maintenance and Reliability

The mechanical gear of the contact rectifier operates in oil. Shaft and roller bearings are liberally dimensioned. After 20,000 hours of operation, no wear could be observed. The oldest contact rectifier made by this company has now given 60,000 hours of service, without a revision of the gear. It may thus be rightly assumed that the revision cycle for the mechanical part will amount to 100,000 hours.

The main contact springs are one of the most heavily strained parts of the rectifier, particularly in 60 cycle plants. They must, therefore, be especially selected. Breakage of springs generally is rare, but cannot entirely be avoided. The springs are easily accessible and can be changed within a short time, in the same way as the contacts.

The lifetime of the contacts is dependent upon numerous factors and contingencies; 6,000 hours may be taken as an average figure. Ac voltage dips (to below 70 percent of rated voltage), or extensive frequency variations, may lead to backfirings. Three ms after initiation of a fault, the short-circuiting switches will close, and thus protect the working contacts from further burn. After most of the backfirings, the contact rectifier can immediately assume full-load operation. Some, however, will require replacement of individual contacts. This, together with a short cleaning procedure and adjustment work, will require about 10 minutes time, according to our experience.

Occasionally, a replacement may become necessary, if a contact should "bounce" for some reason or other. Removed contacts can be machined and used over again, until the soldered-on contact plate (made of a silver alloy) has become too thin.

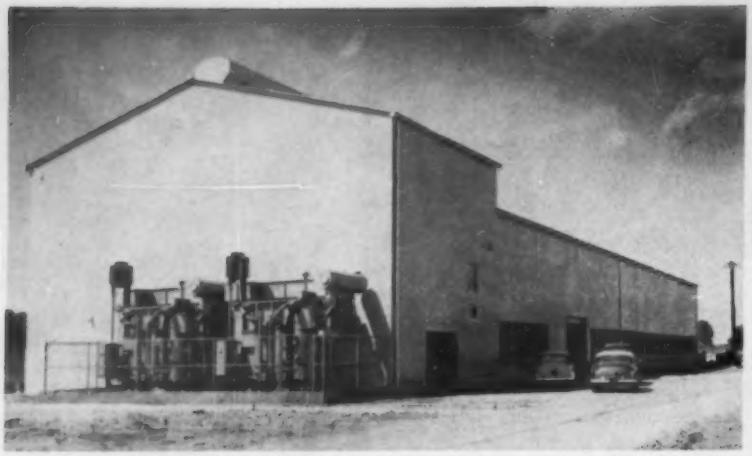


Fig. 3. Refinery building, owned by Aluminum Foils, Inc, Jackson, Tenn. Note two 4000 kw transformer banks in foreground, which supply a-c power for the plant

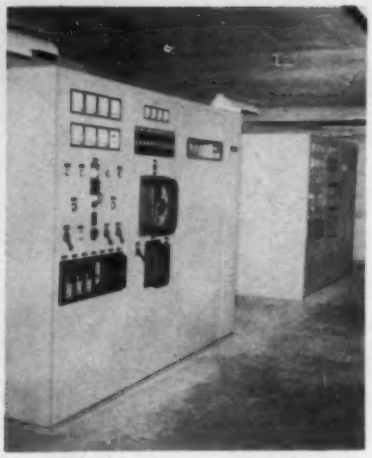


Fig. 4. Rectifier panels, containing instruments, regulators and shunt valves

The yearly cost of contact-replacement, therefore, is negligible. The same applies for the parallel valves (thyratrons) which easily reach a lifetime of 15,000–20,000 hours, in average service.

Supervision of the contact rectifier is accomplished by various warning relays, which will signalize abnormal operating conditions; and, if needed, will shut down the group. Proper contact setting, and the sound working of the contacts, can be checked with a cathode-ray oscillograph, which forms an integral part of each contact rectifier. It is interesting to note that a laboratory-type of instrument is used for the supervision of normal operation. However, after numerous experiments with other methods, this has proved to be the most appropriate, and the safest. The images of the curves are so distinct that operators with limited experience can interpret them.

The auxiliary equipment of the contact-rectifier is slightly more extensive than for a mercury-arc rectifier. Consequently, the location of hidden faults requires a somewhat higher ability on the part of the operator. On the other hand, no vacuum equipment is used. Hardly a basic difference, therefore, exists in the extent of maintenance work required between the two types of rectifiers.

Similar to most of the contact-rectifier installations, the Jackson plant operates unattended. Once during a shift, the electrician (or an instructed helper) will check the proper working of the contacts, and of the rest of the equipment; this requires about 10 minutes.

It has been found good practice to carry out a more extended revision after some 4,000 hours of service, and this requires from 8 to 10 working hours. On this occasion, all insulating parts of the contact apparatus must be properly cleaned.

As in many other plants, the overall efficiency has been determined by two independent methods: 1. the difference between power input and output; and 2. from the sum of the part losses. The following results were established: —

	15,000 A	20,000 A
at 60 V measured by the difference method	93.6%	92.5%
at 200 V calculated from the 60 V results	97.5%	97.0%
at 200 V calculated from sum of part losses	96.96%	96.84%
at 200 V guarantee results	97.2%	97.0%

In consideration of the difficulties inherent in direct measurement, the results must be regarded as a good agreement between the two methods.

Summary

In many years of service the contact rectifier has given proof of its reliability. It requires but little maintenance, and a long lifetime may be predicted. Its high efficiency is a remarkable feature. The units in this plant were manufactured by Brown, Boveri and Co. Helpful information was furnished by Aluminum-Industrie-Aktien-Gesellschaft Chippis, of Switzerland. They have used this type of rectifier for 14 years.

Editor's note: Mechanical rectifiers have been on the market for better than fifteen years. As of today, they have not reached too wide a degree of acceptance; however, the above experience report indicates very satisfactory performance.

In a paper by Trackman, Ingate and Buetikofer — before the AIEE Winter General Meeting of 1958 — some excellent conclusions were drawn. According to their statements, the mechanical rectifier has reached a state of perfection where it is considered to have the highest overall efficiency of any known converter in its voltage field.

The paper further states that recent developments in the commuting reactors used with the rectifiers has permitted the raising of dc voltage output to 700; also that this is not the practical limit. The authors feel that the outstanding advantages of mechanical rectifiers, as presently developed, are these:

1. High overall efficiency
2. Low downtime for maintenance
3. No operator attendance
4. Low maintenance cost
5. Small floor-space requirement
6. Immune to primary voltage dips
7. Automatic current control
8. Unitized construction

Despite the many years of experience with rotary converters, mercury-arc rectifiers and more recent semi-conductors, it would appear that mechanical rectifiers have their rightful place in the dc generation field. It would also seem logical that this means of rectification will maintain its lead over the semi-conductor method, until this latter type has been much further developed. This is particularly applicable to the extremely high-current installations, such as are encountered in the aluminum reduction industry. THE END

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HERE ARE SOME NEW IDEAS YOU SHOULD CONSIDER

Integrated blowdown systems, complete with heat exchangers, flash tanks, sample coolers, pressure flushing of coolers, instrumentation and automatic control; with this can be teamed an automatic water analysis system now on the market which may be used to send a signal to a chemical feed pump whose multiple outputs are adjusted by a low level air signal. The blowdown can be discharged from the boiler drum through a floating fixture which will skim the top surface of the water where the suspended solids are most concentrated.

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In line with the trend to factory-assembled equipment, packaged oil burning units are now available, which combine blowers, heaters, pumps, atomizers, in one cabinet. This unit can be governed by a packaged combustion control, for which the only requirement is tubing connection to the water and steam piping, and electricity.

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There are flow-indicating devices, visual and electrical, which will signal if flow starts or stops. Another version of these devices is a movement indicator to signal motion, or lack of motion, in a shaft, belt or other device.

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A gage snubber, which uses porous elements as the orificing medium, seems a good solution to a vexing problem.

A device is available which, when fitted into the discharge chute of a bin, will eliminate arching or jamming of coal, or other similar substances.

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A package actuator, which will easily "powerize" a manually-operated valve, may be a useful piece of equipment for modernizing.

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For more exotic uses, a gas bearing circulator is made for pumping gases where no leakage can be tolerated.

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There is an automatic shot cleaning system for power boilers which will clean the most troublesome sections of a boiler, where the surface temperature of metal is below the ash-softening temperature.

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Big news is the use of air-cooled heat exchangers for condensing service in power plants. Heretofore, the objection has been that large piping and large radiator areas were required. The new developments utilize a jet barometric condenser; a portion only of the condensate is sent through the air-cooled heat exchanger for re-use in the jet condenser. A special configuration of the fins in the radiator reduces the area required.

Will Your New Power Plant Be Really Modern?

By **PAUL N. GARAY** *

FURNACE INSTALLATION might be improved by the use of a burner unit so designed that combustion occurs almost entirely within the unit. Flame extends from the burner only a very short distance, so that the unit might almost be termed a "combustor." Clean combustion gases and a reduced furnace volume requirement point the way to cheap and efficient boiler design.

In the field of fuel-oil burning, several burners are available, which at high loads economically atomize the oil by pressure alone, and at low loads add the conventional steam jet to create proper atomization.

It would seem from a study of current fuel oil system designs, that the old proven methods of heating, pumping, and controlling oil cannot be improved. This is not so. An electric heating system for heavy fuel oil uses electric induction heating, and thus eliminates the perplexing problems and high costs of steam heaters and pipes, traps, controls and steam requirements. There is no longer any danger of contaminating the feedwater supply with oil from the fuel oil heater drains.

Another new fuel oil system design, for any size of plant, permits the elimination of expensive fuel oil regulating and relief valves, of return lines, and of pumping costs which are conventionally based on 100 per cent delivery at all times. The design eliminates the need for a fuel oil meter on the return line. All the bypasses and valves associated with the meters and regulators are eliminated and yet the system operation is smoother and more dependable than before.

For the utmost in safe operation, the boiler may be fitted with a purge sequence valve designed to provide a secure and hazard-free means of steam purging or scouring oil burner tips. The device is a triple interlocked valve system which dictates an inflexible and irreversible sequence in the control of atomizing steam, fuel oil, and steam for purging the burner tips. Human error, which can be extremely dangerous, is eliminated.

More to come . . .

This review of the latest developments in the design of the various components of equipment that make up a modern power plant, began in POWER ENGINEERING in September, 1958. Mr. Garay will conclude his remarks in a third article, soon to appear, dealing with water control, valves, pumps and simplified maintenance.

Another peril is the explosive hazard due to insufficient purging of a furnace before the lighting-off. A survey of purging practices as performed by various boiler operators clearly indicates that few, if any, have any sound notion of the amount of ventilation needed. This problem can be solved by the use of a flue gas combustibles analyzer which will indicate continuously the combustible content of the flue gases. In purging, when the meter shows zero combustibles, or shows at least a ratio below the explosive percentage, then light-off of the boiler may be safely accomplished.

The analyzer may also be used as a part of the combustion control. Excess air should be reduced until the flue gas analysis begins to show traces of unburned fuel; at such time the excess air is at an absolute minimum, unless adjustments can be made to increase the efficiency of combustion (possibly by adjusting the air directional vanes in the air register, or by changing the position of the burner). The change in combustion conditions due to any such adjustments will be revealed by the combustibles indicator.

In conventional systems, fuel and air are generally supplied to the boiler in a fixed but manually adjustable ratio. In the improved systems of combustion control, the ratio adjustment can be automatically made in

* Associated with Kaiser Engineers, Div of Henry J. Kaiser Co

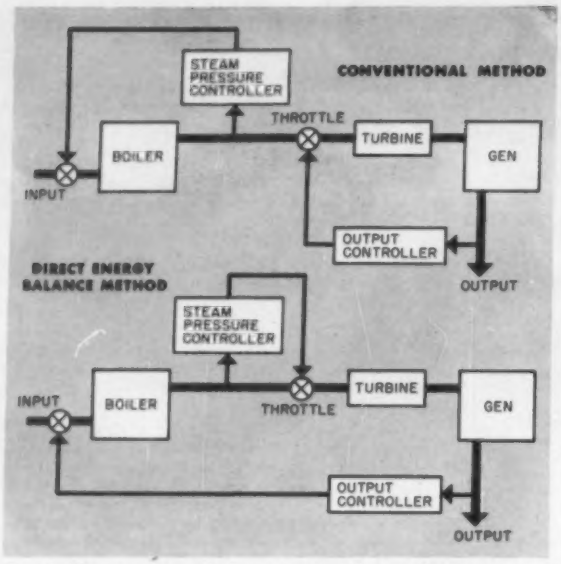


Fig. 1. Direct energy balance is new for combustion control

response to a signal from an instrument which records the percentage of O_2 in the flue gases. CO_2 percentages may also be used in this way, but while CO_2 percentage at optimum conditions varies with different fuels, the excess O_2 at best operation does not change significantly for different fuels. Thus the O_2 meter will make valid corrections without having to be reset for different fuels.

Another version of this type of control is to vary the supply of air in accordance with the amount of excess O_2 in the stack gases. The success of this control will depend on the speed with which the analyzer can take a sample and signal the percentage to the control. A smoke indicator may be used to apply a corrective signal in case the fuel feed outruns the air supply. The combustibles and O_2 analyzers can be bought as one instrument, and some cost-saving is possible because both units use the same gas sample.

An even better way is to arrange for the presence of combustibles in the flue gases call for an increase in the air flow, and an excess O_2 signal would reduce the air flow. When the two signals cancel, the air supply would be at an optimum ratio to the fuel.

Load control is usually applied by keeping the steam pressure at a constant value, and letting the steam governor valve adjust the flow to the turbine. Some of the new plants are using the "direct energy balance" method. See Fig. 1.

Control signal is proportioned to the electrical generator output, and is applied directly to the fuel feed. Better control characteristics result; a boiler-turbine governor component integrates operation of the boiler and turbine as a unit and keeps the output within the capabilities of the auxiliary equipment that is in service.

It is an intriguing speculation that the generator output signal might be applied to the control of feedwater flow, with a level compensation added in the conventional fashion. Such a system might be faster and more accurate than the usual 3-element controls, and might be cheaper.

Instrumentation and Control

Adequate feedwater regulation and good combustion control are dependent upon the accuracy of the primary information which is fed into the equipment. The old reliable "orifice and pressure differential indication" method of flow measurement was subject to error due to the deposits on the orifice, density changes, and nonlinear characteristics.

Consider, therefore, the possibility of using a rotating element flowmeter, or a variable-area type. These can be used either on the main stream, or on a by-pass, if it is desired to save money on purchase costs. Another method by which a smaller size flowmeter can be used is to install it in a venturi section of the line. (The same trick can sometimes be used for valves.) The usual venturi losses are very small. These meters transmit their information electrically, are linear, and retain sensitivity over a wide range of flows.

There are many new instruments available which transmit their information electrically, rather than pneumatically or through mechanical linkage. It is true, that to provide stepless positioning, a pneumatic or hydraulic actuator is much more simple than an electrical one. However, in sensing, transmitting and modulating, the electrical systems are much more simple, reliable and cheaper. Two additional advantages are faster system response and the elimination of the elaborate oil-free, water-free instrument air system which is comprised of a compressor, tubing, filters, regulators, reducers, and elaborate valving.

Almost all of the electrical primary sensing devices utilize a small change in pressure, flow or temperature to produce a variation in the electrical field of a coil within the unit. The exact method by which this is done is of most interest to the control specialists, but practically it is not of great importance and we should use the available electronic equipment for its simplicity and reliability.

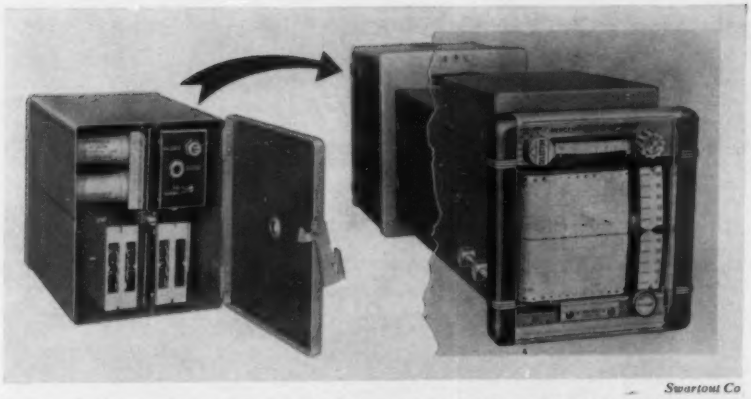
A control system now on the market uses very small and compact sensing units to provide control or recording signals. The controllers and recorders are miniature units which can be assembled in any desired combination by plugging in the component unit for a required function. See Fig. 2.

Typical installation could be a mounting case enclosing a recorder. To this may be added a manual control in the same case, which would be visible through the same panel cut-out. Also, a controller can be plugged into the rear of the mounting case.

Another unique feature is the use of a circuit card containing the necessary resistance and capacity components to cause the control to perform as required. If it is desired to alter the reference points or control features, the card can readily be changed. This control features all-electronic operation; there are no moving parts, slide wires or boosters to initiate control action. Input to the controller is directly from the primary element and is always the same whether pressure, level, flow or temperature is being controlled. The output can be put directly into a self-contained positioning actuator. Several firms now offer electrical control systems of advanced type; "building-block" and also miniature pneumatic systems are available.

Most simple system possible can be built by using the new self-contained actuators to provide the necessary movement at the end of the control system. These units are complete with hydraulic pump, valves, controls, relays and positioning mechanism. They will move any mechanism in response to a very minute signal direct from an electrical control element. These actuators eliminate completely the need for any control air systems within the plant. Special consideration has been given to easy maintenance, with the result that they are very reliable.

Size of a centralized control system is reduced by the large selection of miniature controls and indicating instruments which are readily available. These small units are as rugged, or more so, than their standard sized counterparts. Such miniature units make it practical to install a complex and extensive control system on a reasonably sized console or panel.



Swartout Co

Fig. 2. Control system uses very small, compact sensing units. Controller snaps into place at back of case. Recorder (front) may be partly withdrawn from case

An additional aid in the compactness and simplicity of a control system is the replacement of many indicating and recording instruments by a single multi-point recorder or indicator. Obviously, important savings in cost, installation and space requirements are possible if, for example, ten gages and several recorders are replaced by one multi-point unit. Frequency of each indication is such that, as far as the user is concerned, the record is a continuous line.

Expansion of computer technology and the increasing use of automation make available to the power plant designer many useful new units. For instance, Fig. 3 shows a newly developed flow computer for use in the orifice measurement of fluids. It is the first instrument of its kind. Completely continuous, with full range compensations, it provides extreme accuracy, especially where rapid pressure fluctuations are involved. Responses are fast, since both the static and differential pressure inputs are connected directly to the sensing elements. No pneumatic or electrical relay systems are required.

The same company produces another mechanical unit which can be used to combine two input signals into a single output, in accordance with a large number of mathematical relationships such as squaring, multiplication, sine or cosine functions, etc. One possible use might utilize such an integrator, connected to a load indicator under a coal conveyor belt. The weight of the belt multiplied by the speed at any instant would be the amount of material being moved for a given time.

Librascope

Fig. 3. Newly developed flow computer for use in orifice measuring of fluids

A new Btu integrating meter measures the heat absorbed by a liquid, or the heat removed from the liquid. It finds its widest use in central heating and refrigeration plants. The integrator includes two six-digit counters, one of which shows the total heat in Btu, and the second shows total gallons passed through the meter. Above the counters is a pointer indicating directly the temperature difference of supply and return liquid in degrees Fahrenheit. Many uses can be visualized for such an instrument in a power plant, especially where it may be desired to check efficiency or operating conditions of any component. The instrument might be used to check the heat being lost from a turbine via the main condenser.

Mechanical monitoring functions have also been improved by new types of equipment. Mentioned previously was that one multi-point recorder can be used to record many temperatures at various points throughout a plant. This same combining of information from several sources is used in a temperature monitoring system which is designed to give visual indication at a central location when a temperature at one or more points varies beyond a predetermined limit, and to permit reading at a central location of the temperature of any of these points whenever desired. Provisions are included for simultaneous operation of auxiliary devices and for testing system operation at any time.

One model of this system is a general industrial monitor and indicator and was designed specifically to monitor bearing temperatures in power plants. The instrument is self-supervisory in that any fault of components or in power failure will give an alarm to warn a remotely located attendant. Flexibility of the system lends itself to many other applications.

Some of the distinct advantages of this system are as follows: all points are constantly being monitored; the system contains no moving parts; low cost per installation and building block construction allow additional monitor points to be added without affecting previously installed units. This system, or one similar, should be regarded as mandatory on such applications as bearing temperature indicating, air compressor system, or boiler feed pump temperature monitoring.

This is one way to keep automatic check on bearing temperatures. Drawback, however, to using a bearing temperature as an index to its operating condition is that the temperature senser is not fast enough to detect the rapid localized rise in temperature which occurs when the bearing is failing. A bearing temperature acceleration indicator is available which can indicate imminent bearing failures by means of detecting the acceleration of temperature rise in the affected parts during operation. Thus the machine can be shut down for correction even before bearing temperatures become noticeably elevated.

To supplement the electric indicating alarms, an in-line flow indicator might be used to sound an alarm if oil circulation should be reduced below a set value. This indicator, which can be used on liquid lines of from ½ in. to 5 in., is a cheap way to detect loss of oil flow in lubricating oil and filter piping. It would be a convenient unit for switching in a clean oil filter automatically, once the first filter gets dirty. Another application may be the use of this simple device in bearing cooling water lines.

Another interesting instrument is a foundation subsidence indicator. Large turbine generator units are all carefully aligned at installation, but due to slight movements of the foundation and uneven heating effects on the vertical foundation columns, small changes in alignment are inevitable; they are potentially dangerous in that vibration may develop in the machine. The subsidence gage is installed at the same time as the turbine, and will detect small changes (less than 0.001 in.) in the foundation support.

Still another useful variation of an old instrument is a remote reading liquid level gage which transmits information electrically. Since electrical transmission is used, any number of repeaters can be added, and similarly, alarms can easily be applied. Another advantage is that the datum column can be very simply compensated for density changes in the liquid due to varying temperatures or pressures. Specific application is in the boiler work, where the boiler water density may vary considerably as the system pressure and temperature is raised. Same compensation would obtain in liquid systems where pressure is changed to any extent. THE END

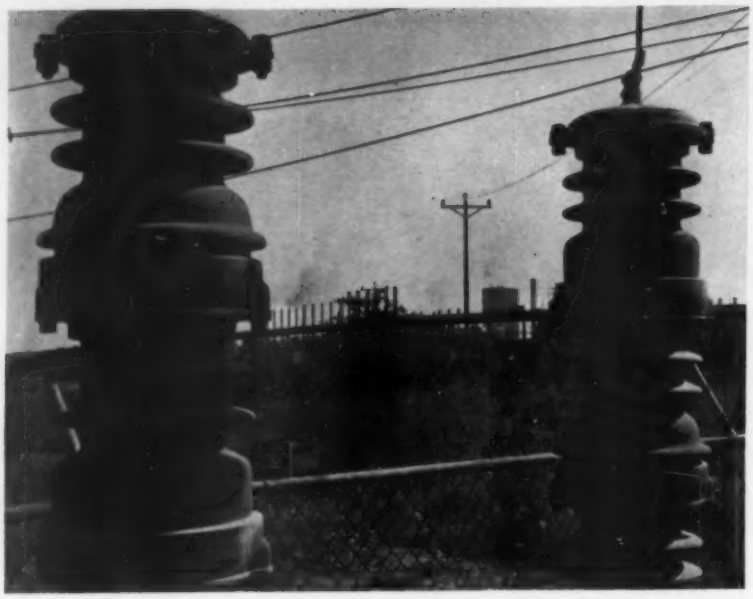


Fig. 1. Dust from stacks of world's largest single cement plant, visible in the distance, once posed insulator-contamination and flash-over problems

Flash-over due to insulator contamination, a power engineers headache of long standing, can now be virtually eliminated and significant savings in maintenance labor realized with this new silicone insulator compound

Alpena Power Reduces Maintenance, Cuts Outages With Silicones

By **GORDON H. SANDALL** *

ALPENA POWER COMPANY is far from the country's largest investor-owned electric utility, but it does have a well deserved reputation for being one of the most progressive. For example, nearly 35 years ago a completely automatic unattended hydro station near Alpena, Michigan went on the line for the first time. Now used as a source of peaking power, this 4000 kw, two-unit station can be put on the line in less than one minute. Far more recent example of progressiveness is the use of a new material to prevent flashover and current leakage on substation and pole line insulators. For Alpena Power Company, insulator contamination has long been a serious problem, especially on a 34.5 kv line adjacent to the world's largest single cement plant, Fig. 1.

One of the earliest steps in alleviating the current leakage and flashover problems on this line was to replace the 34.5 kv insulators with 18-inch post type, nominally rated for 65 kv service. This was done several years ago. While the larger insulators did increase the interval between required cleanings slightly, contamination buildup continued to cause flashover and leakage, and the cleaning problem itself was as severe as ever.

Just how much the interval between successive cleaning might have been extended by the use of larger insulators was extremely difficult to evaluate. The cement plant is located on the edge of Lake Huron and prevailing winds carry industrial dust from the plant over the water and away from the power lines. Consequently, contamination problems can be negligible for extended peri-

* General Superintendent, Alpena Power Co

Fig. 2. Cleaning process previously used involved disassembly, soaking and brushing of contaminated insulators

Fig. 3. When new silicone compound was used for coating, insulators were cleaned in position by wiping with rag

ods. However, a shift in wind or adverse atmospheric conditions can cause insulator contamination to become a suddenly severe problem.

Because cement dust is extremely tenacious, the process for cleaning insulators was involved. Time and labor was saved by actually removing the insulators from the pole crossarms for cleaning. To hold down outage, a second set of insulators was installed while the first set was taken to the shop for cleaning.

In addition to the line itself, two substations are located adjacent to the cement plant property. A similar insulator cleaning problem existed here. Again, to minimize outages, insulators were removed from service wherever possible and taken to the shop for cleaning.

Actual cleaning process previously used is shown in Fig. 2. In this shop photo, an insulator string from one of the substations is shown being disassembled and cleaned with wire brushes and steel wool. Quite an elaborate cleaning process had been developed. Insulators were soaked in an air agitated solvent solution for approximately one hour to help loosen the contaminants prior to scraping. After scraping, a complete rinsing operation was required to remove the solvent solution which, if not removed, promoted flashovers.

With this involved cleaning process a part of accepted maintenance practice, Alpena Power Company initiated a program to evaluate various insulator coatings that might reduce the contamination problem, or at least permit easier cleaning of insulators. Waxes and various other materials were tried, and in May of 1957, we started a program of coating insulators with a Dow-Corning compound.

Because this silicone compound has a consistency similar to that of petroleum jelly, considerable skepticism was expressed initially. Our line maintenance people assumed that the grease-like nature of this material would make our contamination problem even more severe by retaining particles that might otherwise not adhere to the insulators.

First use of this compound was on the insulators of a small substation metering power to the cement company's quarry. On May 16, 1957, during a scheduled outage of four hours, six men removed all insulators and replaced them with new ones coated with this silicone compound. On January 22, 1958, after a flashover and the loss of two fuses during a period of extreme humidity, these insulators were cleaned for the first time without being removed from the substation, Fig. 3.

Cleaning is Simplified

Contamination was removed from the insulators by wiping them with a dry rag. Total outage was only a fraction of the time previously required to remove insulators. Insulators were recoated while installed and required no further cleaning until June 6, 1958.

Results of this first use were so encouraging, especially from the standpoint of cleaning procedure, that a comparative evaluation test was set up at this same substation on January 28, 1958. Four unenergized insulators, shown in Fig. 4, were mounted to a cross-arm structure. The post-type insulator to the far left was coated with a good grade of wax, the identical post type insulator next to it, as well as the two pin-type insulators, were coated with the new compound.

On August 29, 1958, these test insulators were cleaned for the first time. Results: the post type silicone compound coated insulator was thoroughly cleaned in less than fifteen minutes, Fig. 5. Contamination was wiped off easily with a dry rag. In contrast, cleaning time for the identical wax coated post type insulator was a full hour and scraping and rubbing with steel wool was required. Cleaning time for the silicone coated pin-type insulators depended on shape. The one to the far right required only 9 minutes, 10 seconds. The other pin type, slightly over 18 minutes. A total of approximately 43 minutes for all three silicone coated insulators against slightly over one hour for one wax coated insulator proved the new compound far better than anything we had previously used.

Our evaluations to date give this comparative information: by using silicone coating on insulators, three men are able to clean and recoat all insulators in one substation during a two or three hour scheduled outage. An average of two clean-ups per year is anticipated. It is not necessary to remove or dismantle any insulators. Prior to the use of this silicone insulator coating, clean-ups for this same substation averaged three per year. Four or five men were kept busy removing and replacing insulators that could be taken to the shop for clean-up. Scrapers, steel wool and solvents were used on those that couldn't be removed. Two days were required for each clean-up. Outages had to be scheduled accordingly.

New Cleaning Cycle Set Up

Our present procedure is to wipe coated insulators clean with dry rags when moisture fails to bead on the coated insulator surface. After cleaning, Dow-Corning 5 Compound is applied with a paint brush to a thickness of approximately one-sixteenth inch. While we are careful to make sure the entire surface is covered, no extreme precaution to assure an entirely uniform coating seems necessary.

Our experience with this insulator coating indicates that its use will result in substantial savings, both in fewer outages of shorter duration and in reduced maintenance. While our experience has been restricted principally to one type of insulator contamination, we believe that coating insulators with this material is a procedure which warrants consideration by any utility or industrial company with an insulator contamination problem. THE END

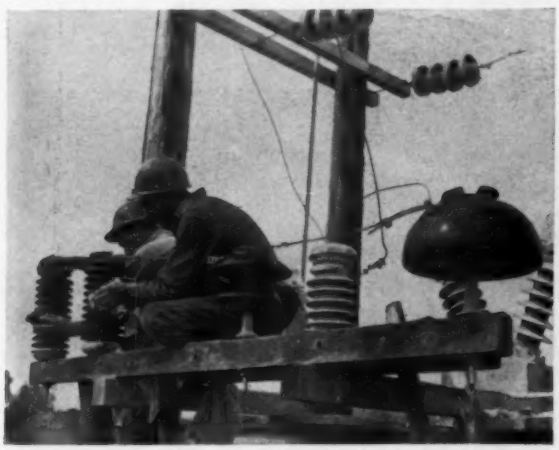
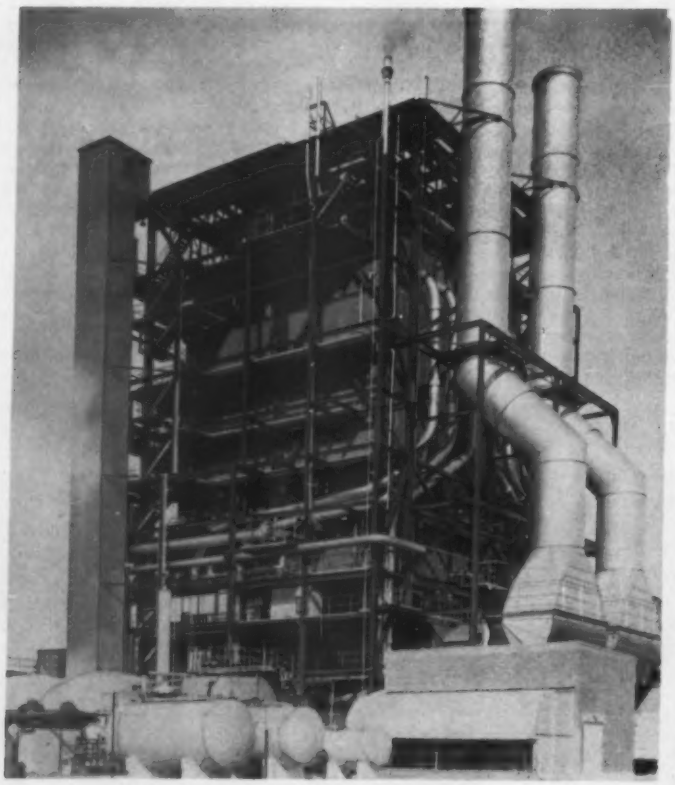


Fig. 4. View of comparative evaluation test rig, as described in text, used for determining performance of compound

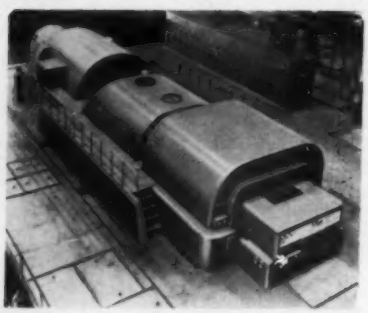
Fig. 5. After test all three silicone-coated insulators were cleaned with a dry rag in approximately 43 minutes

POWER ENGINEERING'S NEWS REEL

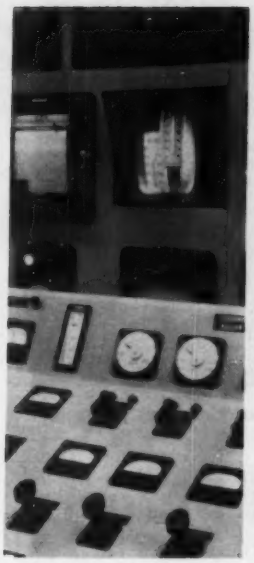


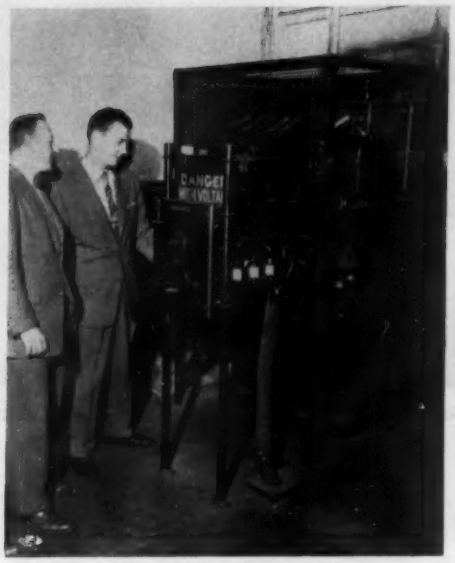
New boiler for Louisiana Power & Light Co is this 130-ft high unit at Sterlington, La. Design incorporates Riley Stoker's turbo-furnace, and the boiler has been given an outer skin of Avoncraft porcelain enamel, for weatherproofing. Height expansion of 4½ in. is allowed for

Fermi atomic power plant at Monroe Mich, gets two of three sodium heat exchanger shells from Alco. They're solid stainless steel, nearly 31 ft long



Largest turbine generator in northern Wisconsin is this new Allis-Chalmers 75,000-kw steam unit now in operation at Wisconsin PSC's plant in Green Bay

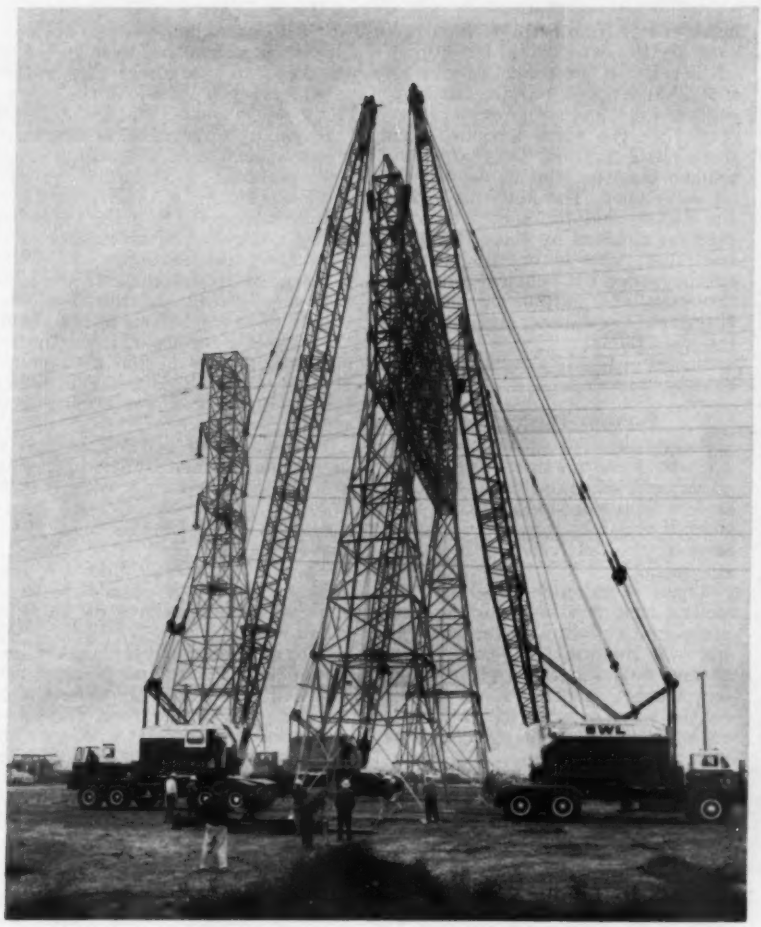




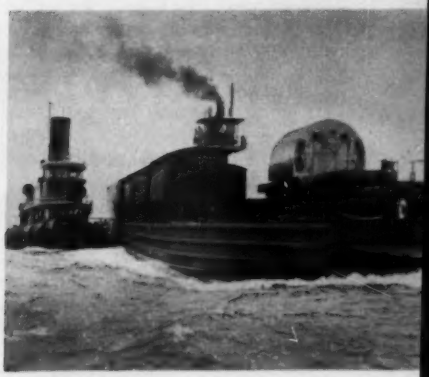
Semi-buried transformer enclosure (far left) for underground distribution systems now comes as a package complete with G-E 167-kva transformer and two fused disconnects. Top of dome projects only 33 in. above grade

Closed-circuit TV (center) gives operator a monitor for watching water level gage on boiler located in another part of the plant. Du Mont camera at boiler site relays picture of gage to control room panel (note right unit)

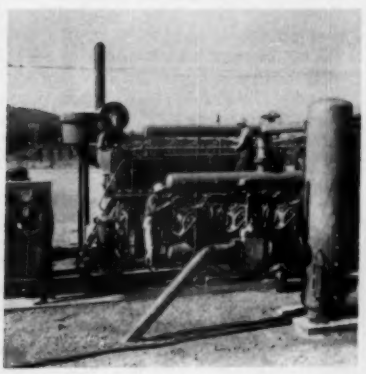
Oldest industrial capacitor installation in the country is said to be this 40-year-old apparatus (in cage) at RCA's plant in Harrison, N. J. Slated for retirement soon, it will be replaced with modern pole-top equipment



Big lift—a 95-ft-high transmission tower bearing 18 high-tension lines, 12 of them energized—is accomplished by 4 huge cranes attached to legs of the tower. Tower was relocated 71 ft from original site. Done for Southern California Edison Co, the job took 3 hours. The 12 h-v lines were kept in service



Generator takes to water, across choppy Hampton Roads, in trip from Allis-Chalmers plant in Milwaukee to Yorktown Station of Virginia Electric & Power Co. Stator weighs 450,000 lb



Gas engine compressor recently put on line by Atlanta Gas Light Co is a Worthington unit which delivers at discharge pressures of from 190–275 psig

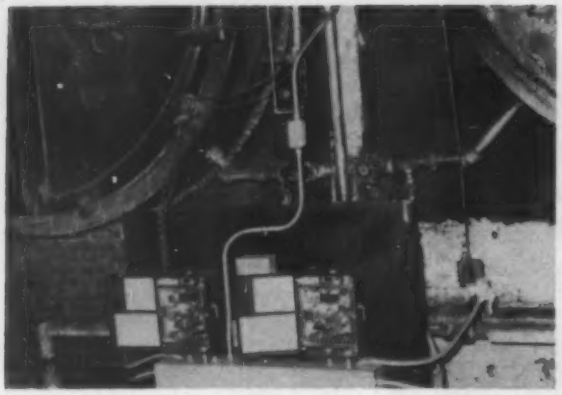


Fig. 1. Automatic controls for operating a small HRT boiler

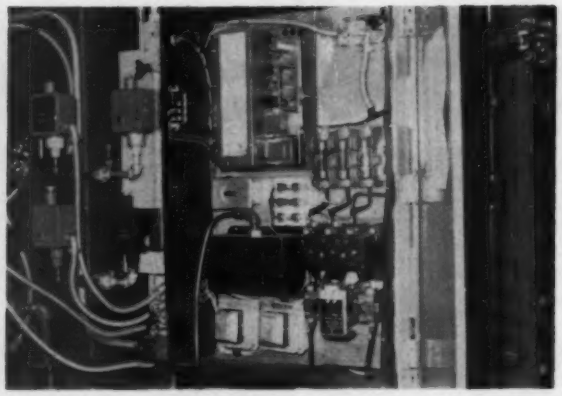


Fig. 2. Water-tube-boiler control box described in the text

Automating Steam-Atomizing Burners

. . . is practical, saves money

By ROBERT J. BIZZELL *

AUTOMATION OF steam-atomizing burners is well within the realm of practical application. With modern electronic combustion controls, it poses no problems with which reasonable mechanical ability cannot cope.

There are several types of mechanization that have been successfully attempted. The only limitations to be conformed to are those imposed by the State and City Codes, insurance requirements, and, of course, the physical limitations of the automating equipment.

One application is the fully-automatic operation of flat-flame burners as applied to small and medium-sized HRT boilers. This system includes all the necessary appurtenances for prepurging burner with steam, automatic proved gas electric ignition, oil-valve programming, flame-failure, low-oil-pressure, and low-steam-pressure shutdowns, manual-reset low-water protection, and burner-post purge.

The burner will modulate electrically between high and low fire with infinitely variable steps. Upon reaching cut-out pressure, burner will shut down, and a drop in steam pressure will permit burner to automatically re-light.

On this application, we specify an excellent electronic programming control used largely in controlling rotary cup burners. It utilizes a lead-sulphide cell as a scanner. Thus it has the ability to scan and prove the gas pilot.

A normal cycle on this particular installation is as follows: On a cut-out rise in pressure, the solenoid oil valve closes. The solenoid steam valve remains open, purging the burner of oil until the programmer reaches its cycle end. The programmer automatically returns the electric modulating motor to low-fire position preparatory to next cycling.

On a fall in pressure, the solenoid steam valve opens, purging burner of condensate. The programmer then opens the gas valve and institutes the electric ignition. Only after the scanner sees the pilot flame, can the oil valve open. The unit then drives the electric modulating control to the position dictated by the modulating controller. After a time limit, which can be varied by a choice of ignition terminals, the ignition assembly de-energizes. The scanner then monitors the main flame.

This is only a brief synopsis of the control functions.

Further Protection

As additional safeguards, we apply a pressure control in series with the oil valve. This control is piped downstream from steam solenoid valve. If steam valve fails to open, or fails in service, the oil valve will be de-energized.

There is a low-voltage operating control that is wired into the operating-limit circuit. This pressure control will operate the burner in its normal range. If this control should fail, there is another limit pressure control wired in series with low-water cut-off, and gas pressure control that will assume command. The second control is, of course, line voltage, as are the low-water cut-off and the gas pressure monitoring control. The gas control is upstream from the electric gas valve.

As this particular application was new, we used a second control in the low-voltage circuit. Its function was to prevent operation of the burner if the steam pressure was to fall to a point that quality of atomization would be affected. For convenience, all low-voltage controls were mounted on the main panel with the electric modulators and flame-failure devices. Line voltage controls were installed on the water column. The entire panel was set in place over the modulating steam and oil linkage.

Originally a hydraulically-operated pressure controller was mounted at this position; modulating motors drive oil, steam, secondary air, and uptake dampers in response to modulating controller. Convenience dictated the panel location.

To prevent waterlogging on low-voltage operating controls, the control line was trapped six inches above the control locations. This eliminated any water head in the piping and eliminated the need for calibrating the operating and modulating controls.

Our choice of control voltage is largely determined by the operating voltage of solenoid coils. We maintain a supply of various coils, but nearly all are of a 230 v rather than 115 v rating.

Steam lines to the burner are carefully trapped with impulse traps to maintain the lines free of water in down time.

The particular oil valve that is used has a temperature and pressure rating well within safe limits for the oil pressure and temperature. The steam valve was to be used at a pressure not exceeding 150 psig or 365 F. The steam and oil valve coils are both Class H insulation. The manufacturer's rating should never be exceeded.

A typical wiring diagram is shown in Fig. 3. This installation has been in service for ten months with no difficulty to date. Upon start up, it was found necessary to install strainers ahead of oil valves, as pump suction strainers were too coarse and

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permitted material to lodge on valve seats, causing drooling.

We stood several watches on the boiler plant to familiarize operators with operation of equipment. Experience has proven that it would be advisable to utilize two separate scanners, one for main flame and one for pilot flame. The scanner selection would be made by a relay, DPDT, controlled by programmer. This would permit more latitude in placement of scanners.

Shielding Required

Great care should be exercised in the selection of the scanner relay. It is quite possible to induce a false signal in the scanner circuit, possibly reading ignition where none actually exists. The relay should be non-inductive as applied to the circuits that are switched. Extreme caution should be taken to shield the scanner circuits from outside a-c influences, with a continuously-grounded shield from cell to controller. All junction boxes carrying scanner wires should be plainly marked to prevent their utilization for any other purpose than scanner wiring. This applies to all lead-sulphide-cell controls, irrespective of manufacturer.

Flame rectification setup is not sensitive to induced a-c currents, so can be installed without shielding in conduits carrying alternating current. Compliance with local oil burner and wiring codes should be observed. Good practice would suggest the use of a separate conduit for photo cell wiring, with a solid ground and flame wire run from cell to control.

Another application is of a different nature. The burners fire a 90-in. rotary kiln. They stabilize the combustion of a waste material.

As this kiln has other than oil being burned in it, it posed a problem in control selection. The lead-sulphide cell being sensitive to infrared, would be affected by the burning material in the event of a flame failure on the steam-atomizing burner. It was decided to use a flame-rectification cell to monitor the oil fire.

This cell is predominantly sensitive to the ultra-violet end of scale. It requires a high-intensity light to energize cell. Consequently, we felt that it would not see the burning material in kiln.

As an additional precaution, we sighted the cell at the eye of the kiln where it enters the waste heat boiler. Subsequent experience proves that the selection was sound. The burning material rings on the kiln and tongues of flame occasionally intersect the line of sight. Despite this, the cell reads only the oil flame.

We chose flat-flame burners of narrow flame angle to assure long flame travel, this to allow the long fire to radiate to the material the length of the kiln.

Burner is monitored by low steam-pressure and oil-pressure cut-off, and an electronic flame-failure device. The oil valve is a manual reset type. It requires manual opening after closure; this to forestall the possibility of the control dropping the valve out and allowing it to re-open after fire has gone out. The control is shunted out on torch light-off by a normally-open push-button station, accessible from the operator's light-off position in close proximity to reset oil valve.

Sighting the Scanner

Sighting of the scanner is most critical. On proved pilot installation, it must not read less than the minimum pilot necessary for ignition of main flame. The burner scanner must not sight on adjacent burners in single furnace or on high-temp refractory. The lead-sulphide cell and its primary control screen out all but flame frequency, but hot refractory can cause a shimmer that could excite the control.

If a highly-radiant background exists, the steam from the burner itself can cause a shimmer that will produce a false signal. If the radiant background is unavoidable, opening the steam valve with the oil valve will alleviate this difficulty on start, and orificing will help on flame failure. But our suggestion is to utilize a flame rectification set up with a photo cell for main flame, and a flame rod for pilot, rather than the lead-sulphide cell. The sighting should preferably be on the boiler black surface if possible. The flame rectification set up can be excited by incandescent refractory if of sufficient luminosity.

More detailed instructions as to restricting view by orificing and determining length of scanner mounting tube can be obtained from manufacturers. The recommended sight positions will also be set forth in these manufacturers' instruction sheets.

At present we are automating a 10,500 lb per hr water tube boiler. It will be very similar to the first application, with the exception that a forced-draft fan will be used, operated by a pressure controller. The limit circuit will have the low-water cut-off, a pressure control and a draft proving device. The operating control circuit will have a high and low-limit operating control with selector switch, low-gas, low-oil, and manual shut-down switch.

A low steam interlock is wired in series with the oil valve downstream from the steam valve. Low oil or low gas interlocks should never be wired in series with oil valve, as pressure fluctuations could cause rapid opening and closing of the oil valve.

Forwarding control set-ups have been used by us to monitor rotary-cup and press-atomizing burners, in addition to the steam-atomizing burners. THE END

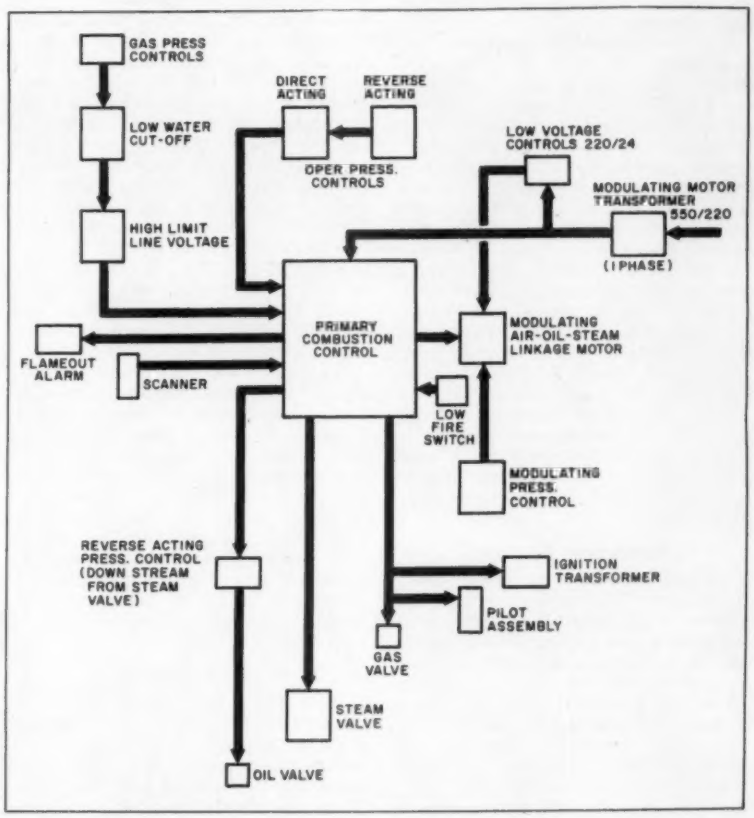

Fig. 3. Schematic control diagram. Arrow indicates the impulse control direction

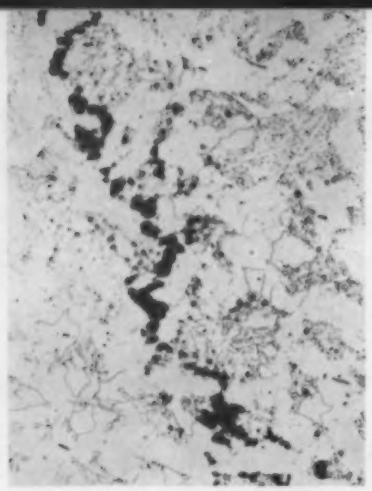

Fig. 1. Chain-type graphite in sample taken from reducer, magnification 100 X

Oak Ridge Reports on

Reviewing progress of graphitization in carbon-moly steel components of the Gaseous Diffusion Plant power station, rehabilitation measures are described, as are two failures

By C. H. MAHONEY* and W. S. DRITT*

THE POWER STATION at the Oak Ridge Gaseous Diffusion Plant consists of three boilers, each rated at 750,000 lbs of steam per hr, connected by leads to a common 16-in. distribution header supplying steam to 14 turbines (Fig. 2). The station was built during World War II for the Manhattan District, U S Corps of Engineers, by private contractors and had been in operation since April, 1944, in excess of 100,000 hr. Design operating conditions are 1325 psig and 935 F.

Failures occurred September 4 and September 17, 1957, in the main steam piping system because of serious graphitization in carbon-molybdenum forged steel reducers. Both these occurrences created grave hazards to personnel, but the portion of the system involved was successfully taken off the line in each instance without additional complications and with no injury to personnel.

Carbon-molybdenum steel components of this piping system were replaced with 1¼ per cent chromium — ½ per cent molybdenum steel following the failures. The findings from an exhaustive study of the piping system of the No. 3 Boiler are presented for the benefit of users of carbon-molybdenum steel components in high-pressure steam systems. A brief history of the program for the control of graphitization in the station is also presented.

History of System

Sampling program for determining the progress of graphitization in this system was initiated in 1950 after metallographic evidence of graphite had been found in exploratory probe samples taken from pipe joints in 1949. All graphite noted had been either mild or moderate in classification, with a random distribution, and of nodular form. The program in 1950 consisted of first sampling the valve and piping joints that were closest to the boilers in the main steam system and, therefore, offered the greatest potential hazard in case of failure.

Sampling was done during normal annual outages and was scheduled to progress down stream toward the turbines until a satisfactory survey of the complete system had been made. The sample surveys made through April, 1957 revealed that the weld heat affected zones of valve castings were particularly susceptible to serious graphitization while the piping joints were usually non-sensitive.

Samples taken from one of these severely-graphitized valves produced no better than a 45-deg bend after normalizing for two hours at 1700 F, nor did a treatment for four hours at 1700 F improve the results. It was concluded advisable, therefore, to replace the valves with chromium-molybdenum steel.

Criteria for evaluation of graphitized samples were modified slightly in 1955 to agree essentially with those advised by Thielsch (1). Because of the extremely high cost of down-time at this station, due to demand for the generation to manufacture U 235, a single step rehabilitation by normalizing at 1700 F for 2 hours was used. The studies had shown that an expectancy of 5 years of safe life resulted from this treatment, at which time joints could be flame-gouged, rewelded, and normalized at costs comparable in this station to the double treatment of normalizing followed by drawing at 1300 F.

Prior to the 1957 failures of two forged reducers, the program had resulted in study of more than 250 samples through the means of over 600 laboratory determinations.

As a result, ten valves had been replaced with chromium-molybdenum steel, 18 had been normalized, and 4 had been flame-gouged and rewelded. The boiler lead stubs, superheater headers, and the non-return valves and intervening piping had also been replaced with chromium-molybdenum steel. In addition 71 pipe-to-pipe joints had been normalized, although the mild graphite noted infrequently in such joints had not been accompanied by a detectable loss in ductility.

1957 Failures

First failure in a forged reducer occurred under normal, full load conditions as a crack 8 in. long in the reducer connecting the 12-in. lead from No. 3 Boiler to the end of the 16-in. distribution header.

Second failure occurred while the survey and repairs to the No. 3 Boiler system were in progress. The rupture was in a forged reducer connecting the 8-in. steam lead from the No. 1 Boiler system to the throttle valve of the No. 3 Turbine. The reducer was found to be severely graphitized and the break had apparently occurred along a path furnished by an eyebrow formation of graphite.

Following the initial sampling of the main steam header and reducer joints of the No. 3 Boiler, the insulation was stripped from the carbon-molybdenum steel portion of the system from top to bottom, ending with the turbine casings, to insure the positive location of all joints. Ninety-six samples, the majority of which were so taken that they represented two components in the system, were removed for study.

Guided bend tests, chemical analyses, metallographic observations, and McQuaid-Ehn grain size evaluations, totaling 474 laboratory determinations, were made on these samples. All components were sampled at least once, and some were resampled: 1, after normalizing for two hours at 1700 F; 2, after the same normalizing treatment followed by drawing at 1300 F; and 3, after flame gouging, rewelding, and normalizing.

Thoroughness of the program on No. 3 Boiler permitted an exact cost study of the various types of rehabilitation work that had been performed. When the cost of replacement of all carbon-molybdenum components with chromium-molybdenum was balanced against partial replacement plus the cost at this station of a continued rigid sampling program and rehabilitation after a five year interval, it was found that total replacement presented advantages and could be done at comparable cost.

Conclusions

Results of this study show the need for extensive information and a rigid sampling program on all components in a carbon-molybdenum steel piping system that is operating under high pressure and high temperature conditions.

Dependable estimates of the sensitivity of carbon-molybdenum steels

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This article is based on work performed at the Oak Ridge Gaseous Diffusion Plant operated by Union Carbide Corp for the U. S. Atomic Energy Commission

Graphitization In H-P Steam Lines

to graphitization cannot be achieved on the basis of any known single method of analysis. Rather, the combination of chemical composition, McQuaid-Ehn grain size determinations, metallographic interpretations of abnormality, and knowledge concerning freedom from locked in strains from fabrication sources are required.

Aluminum contents of 0.025 per cent or less do not necessarily mean that either forgings or piping will be nonsensitive to graphitization. Both of the forged reducers in which the September, 1957, failures occurred had aluminum contents of 0.020 per cent, while graphite of a mild to moderate class was found in piping having abnormal structures and aluminum and molybdenum contents of 0.01 per cent and 1.00 per cent, respectively.

Structure, and its associated grain size, appears to have a dominating influence over low aluminum (<0.025 per cent) and high molybdenum contents, since moderate graphitization was found to have occurred in weld heat affected zones of piping having 0.01 per cent aluminum and 1 per cent molybdenum. Molybdenum contents of 0.7 to 1.0 per cent, however, do appear to minimize the influence of abnormality. Samples that were similar in degree of abnormality and low aluminum contents, typically contained graphite of a lower classification if the molybdenum content was 0.7 per cent or greater.

There is reason to doubt that multiple samples from the same joint are beneficial. Eleven joints were sampled at three or more positions on the circumference and the deviation between samples was slight. The same order of deviation can be created on an individual sample by taking the sample back to a No. 1 paper and repolishing.

With the exception of turbine stop valves and turbine casings, castings were not considered in this study, but previous experience at this station with valve castings had shown them all to progress to a stage of severe graphitization. The more recent results showed that forgings can progress similarly, and that probably only those that have a fully-normal structure and a small grain size can be expected to be nonsensitive to graphitization. Sensitivity of forgings to graphitization may vary from nonsensitivity to sensitivity of a high order, and is probably influenced by variations in manufacturing technique from forging to forging or from lot to lot. Therefore, expectations of such components cannot be determined by random sampling and must be based on a 100 per cent sampling approach.

Wrought carbon-molybdenum piping such as was found in this system is typically non-sensitive to graphitization, but infrequent lengths occur that are sensitive. Severe graphitization can occur even in mildly-sensitive piping when it is assembled so that high stresses are imposed in service. This is typical of stub welds, where severe graphitization occurred over an area extending as much as two inches from the weld heat affected zones.

Complete sampling of the entire system can be combined with thorough and qualified analysis and a scheduled resampling program to insure safe operation of a carbon-molybdenum steel system. The cost of such an extensive program, however, can be extravagant, and replacement with chromium-molybdenum steel may have advantages, particularly in those stations where down-time carries a high penalty factor.

THE END

Reference

(1) Thielsch, Helmut, Phillips, E. M., and Jerome, E. R., Jr., Considerations in the Evaluation of Graphitization in Piping Systems, Supplement to the *Welding Journal*, June, 1955.

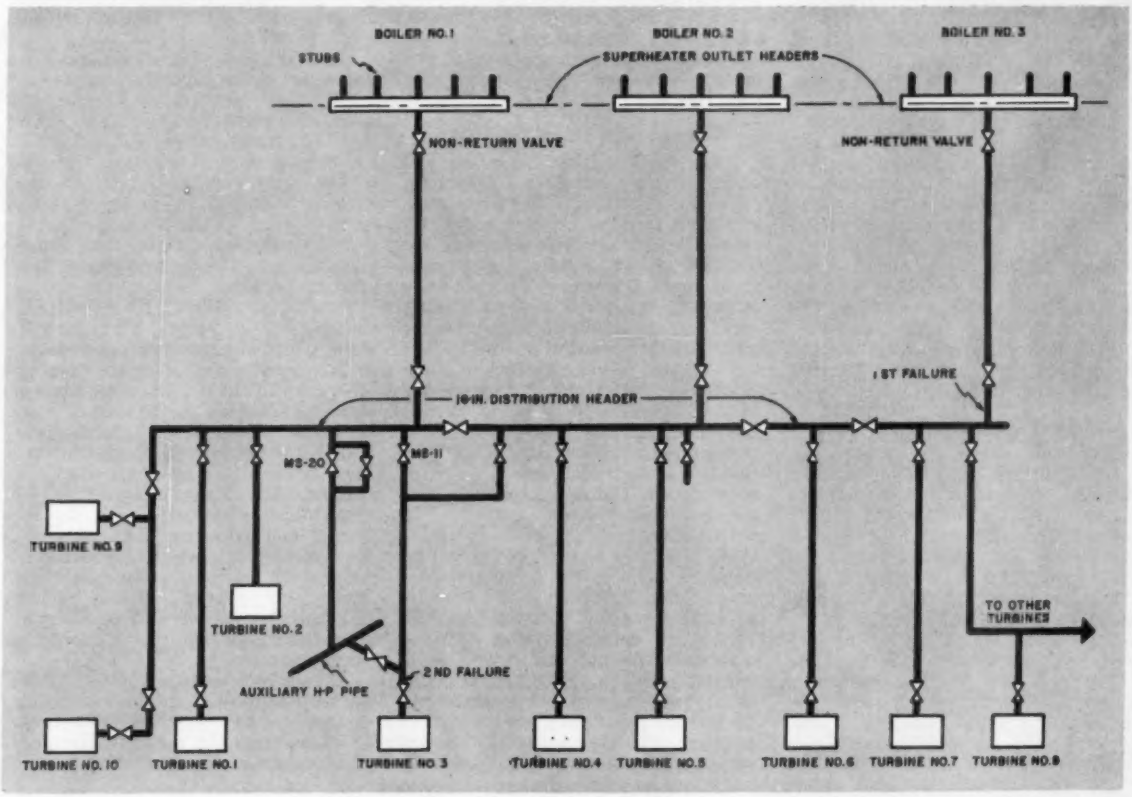
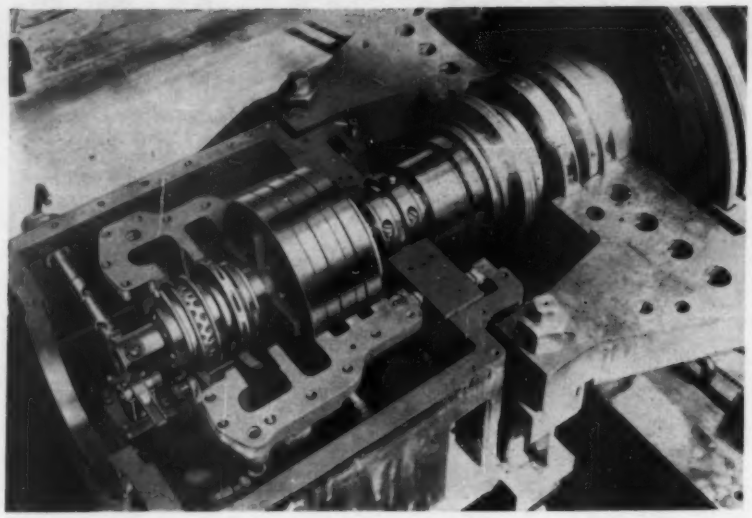


Fig. 2. Schematic of the main steam piping, showing the location of the two failures. Sampling and replacement continues

Fig. 1. Cut-away view of turbine pedestal gives excellent view of emergency governor and overspeed trip mechanism



In reaching their present high state of refinement, control systems of modern steam turbines have become increasingly complex. A thorough knowledge of their function is a must for the competent operator. This article helps you to . . .

Know How Your Turbine Controls Work

By J. D. CONRAD, JR.*

UTILITY-TYPE TURBINES use a completely hydraulic governing and control system which, in conjunction with the lubrication system, constitute the complete turbine oil arrangement. Fundamentally, turbine controls have the following main functions to perform:

1. Regulation of the flow of steam to the turbine at all points, and

2. Protection of the turbine-generator from failures associated with the turbine itself or the failure of other station equipment. For example, if the axial movement of the turbine shaft exceeds a predetermined value, the thrust trip device will automatically close the main steam inlet. Throttle pressure regulator will reduce the load to the point where the proper pressure can be maintained.

Two basic oil systems are used at the present time, one using 150 psig and the other using 300 psig.

150-Psi Control System

The backbone of this system, Fig. 2, is the turbine shaft-mounted main oil pump whose discharge is used as a source of supply for the oil ejector, the lubrication system, the control system and as a backup supply for the hydrogen seal oil system. Discharge pressure of the main oil pump is normally 135 to 150 psig.

Oil ejector, which has no moving parts, furnishes oil to the main oil pump inlet at a positive pressure of approximately 25 psig. A portion of the main oil pump discharge is used as motive oil to operate the ejector which is mounted in the oil reservoir along with the orifices, check valves and necessary piping required to balance the oil system.

Governing system is principally responsible for performing two jobs: (1) respond to minute speed changes; and (2) convert changes in speed into proper changes in steam flow to maintain constant speed. To perform these two functions, a governing system consisting of the following basic components is used: (a) a speed responsive governor; (b) a speed changer; and (c) hydraulically operated servomotors for positioning the governing steam valves.

Speed and Load Control

Turbine speed is sensed by a small oil impeller mounted on the turbine rotor, Fig. 2. Change in oil pressure produced by this impeller when the turbine speed varies is amplified by the main governor to a higher governor control pressure. This pressure is used to operate a hydraulic relay which in turn admits high-pressure oil to the servomotor operating piston. Steam valves, which are positioned by the servomotor operating piston, open on decreasing control pressure and close on increasing control pressure. When the turbine is tied to a system and runs at synchronous speed, the speed changer becomes a load changer.

In addition to the main governor there are other sources of control oil pressure such as the auxiliary governor, load limit valve and throttle pressure regulator. These controllers, Fig. 2, are connected to a common manifold through one-way check valves; therefore, the controller maintaining the highest oil pressure will control the manifold pressure and the position of the governing steam valves. For example, the load limit valve can be set to allow a minimum manifold oil pressure thereby setting an upper limit on the amount of load that can be carried by the turbine.

Protective Steam Valves

In addition to the governing steam valves which are responsible for the precise regulation of speed and load, additional steam valves are used to protect the turbine. These valves are listed below and their location in the system is shown in Fig. 3.

Throttle Valves. To provide double protection in the high-pressure steam inlet lines, throttle valves are used in series with the governing valves. The primary function of the throttle valves is to shut off the flow of steam to the high-pressure section of the turbine. Although these valves normally operate in the wide-open position, they are also used for controlling steam flow to the turbine during the start-up period.

Interceptor Valves. Even though the governing valves have closed, there is still enough entrapped steam in the reheater and associated piping to overspeed the turbine when a large electrical load is lost. To shut off this supply of steam to the intermediate and low-pressure sections of the turbine, interceptor valves are used.

Reheat Stop Valves. To provide the same double protection for the reheater inlet to the turbine that exists for the main steam inlet, reheat stop valves are used in series with the interceptor valves. These valves, like throttle valves and interceptor valves, normally operate in the wide-open position.

Extraction Non-return Valves. These valves are located in the extraction steam lines to prevent the back flow of steam from the regenerative feedwater system to the turbine. The

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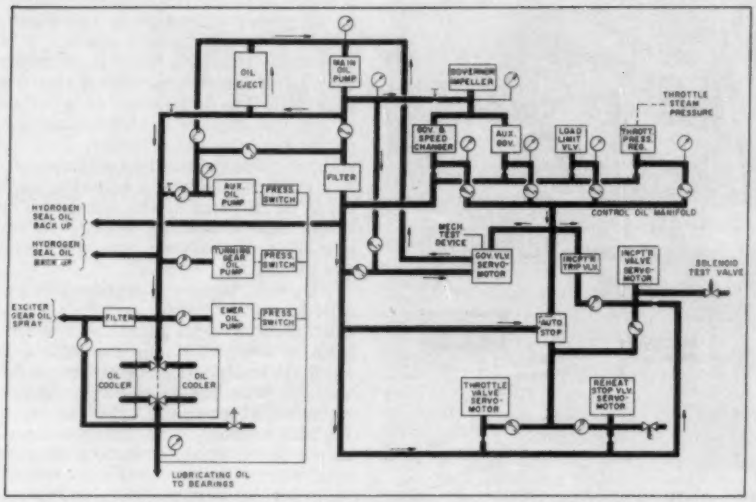


Fig. 2. Control diagram for 150 psi system operating control valves shown below

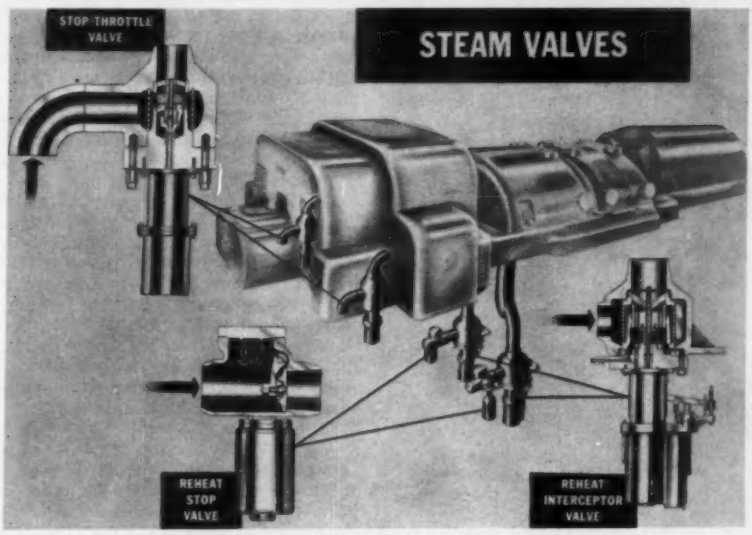


Fig. 3. Turbine steam valve layout shows control function related to diagrams

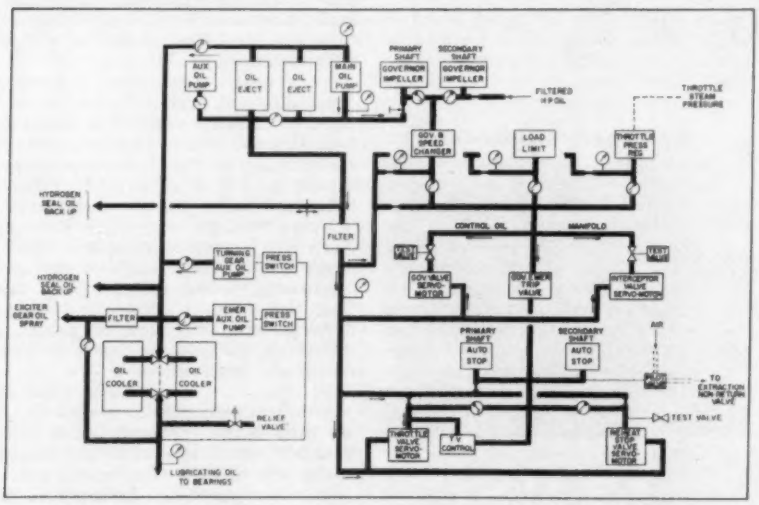


Fig. 4. Control diagram for 300 psi system operating control valves shown above

valves are of the swing check type and are either air or oil operated to insure positive closing.

Protective Devices

All of the steam valves previously discussed are under the ultimate control of the autostop trip valve. This valve will cause all the steam valves to close if emergency conditions arise. The autostop trip valve can be made to operate by any one of the following protective devices:

1. Overspeed emergency governor.
2. Low operating oil pressure trip.
3. Low bearing oil trip.
4. Low vacuum trip.
5. Thrust trip.
6. Electric solenoid trip.
7. Manual trip.

In addition to the protective devices that will trip all the steam valves closed, other devices such as temperature and pressure controllers are available that will decrease the turbine load or simply sound alarms when abnormalities exist.

Load Dump Operation

When all, or a large portion, of the electrical load carried by the generator is suddenly lost, it is not uncommon for the rotor to accelerate at 300 to 450 rpm per second. With accelerations of this magnitude, it is essential that all the available sources of steam to the turbine be cut off as quickly as possible to avoid excessive overspeed.

Therefore, in order to satisfactorily control the turbine speed when a large percentage of the load is lost, the governing and interceptor valves must be closed in a fraction of one second. To accomplish this quick closing action, the main governor is assisted by an auxiliary governor which is connected into the control oil system, Fig. 2.

Auxiliary governor now being used is acceleration responsive; that is, it will assume control when the rate of change of speed exceeds a predetermined value. Auxiliary governor will continue in operation for a short time after the governing and interceptor valves are closed at which time it will return the speed control of the turbine to the main governor.

300-Psig Control System

Due to development of turbines using higher steam pressures and larger flows, it has become necessary to increase the servomotor-operating oil pressure in order to maintain reasonably-sized steam valve operating mechanisms. Principle differences between the 150 and 300-psig systems are as follows:

1. Source of bearing oil. The 150-psig system takes the bearing oil supply at 150 psi and reduces the pressure to the correct value through an adjustible orifice as shown in Fig. 2. The 300-psi system takes the bearing supply from the oil ejector discharge which is approximately the correct pressure.

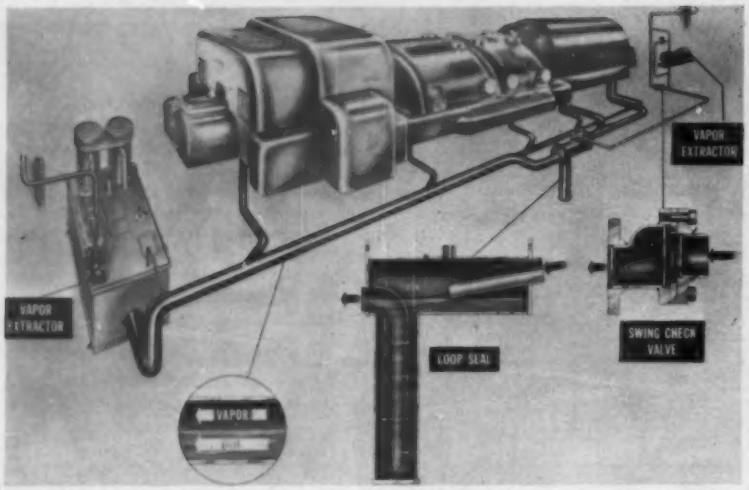


Fig. 5. Hydrogen isolation system. Vapor extractor insures proper ventilation

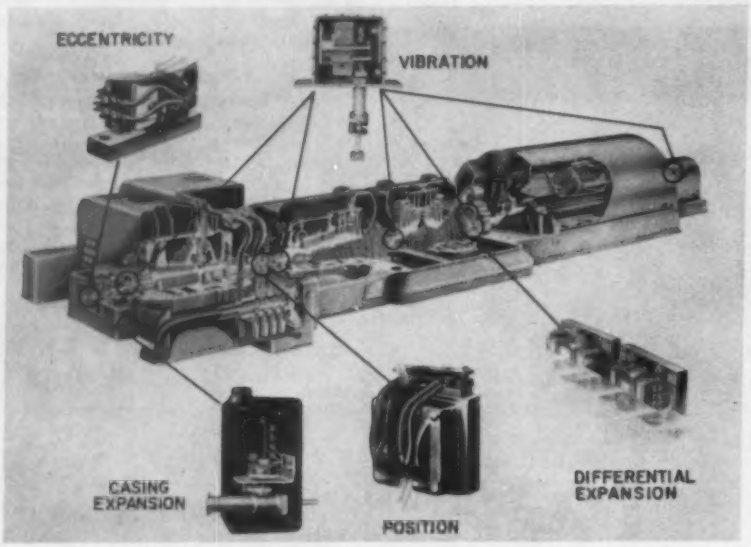


Fig. 6. Diagrammatic view of turbine supervisory instrument monitoring locations

2. Relation between *control oil pressure* and kilowatt load. The 300-psi system uses a control pressure that is directly proportional to kilowatt load. It will be recalled that this is opposite to the load-control pressure relationship used with 150-psi system. As can be seen in Fig. 4, the controller (main governor, load limit valve or throttle pressure regulator) maintaining the lowest oil pressure will regulate the control oil manifold pressure thereby controlling the load on the turbine.

The 300-psi system, Fig. 4, does not incorporate a separate auxiliary governor due to the fact that the main governor has an acceleration-responsive feature and will cause the steam valves to close quickly when necessary.

With the increased complexity associated with higher operating loads, temperatures and pressure, and with the desire to start and load turbines more rapidly, it is becoming essential that the turbine operator have some reliable method of determining what conditions exist at certain points within the turbine at any time.

Supervisory Instruments

To determine such conditions as those previously mentioned, a new and improved complement of supervisory instruments, known as the "Turbo-Graf Line," is now being used, Fig. 6. These instruments are capable of both indicating and recording several variables. Continuous records are desirable in that they can be used to establish a normal operating pattern for a given unit thus helping the operator to discover any dangerous trends that might develop during either starting and stopping or over a long operational period.

Spindle Eccentricity Recorder. When a turbine is shut down, it is possible that the rotor may become slightly bowed due to uneven cooling if proper turning gear operation is not maintained. When the unit is started, it is important that the rotor be straight before the speed is increased above a slow roll. The indication of whether or not the shaft is straight is the job of the eccentricity recorder. This instrument consists of two pickup coils mounted diametrically opposite each other at the end of the spindle. The instrument measures change in air gap distance between the rotor and the pickup.

Shaft Vibration Recorder. Being able to measure and record shaft vibration at several points on the turbine is important for two reasons. First, it enables the operator to determine whether or not the shaft is balanced at the time of initial starting and secondly, a continuous record of vibration enables the operator to spot any vibration build-up over a long period of time thus indicating possible trouble inside the turbine. The instrument consists of a seismically mounted electromagnetic pickup whose movable coil is actuated through follower shoes on the turbine-generator shaft. Several pickups are generally used to indicate vibration at different points. The record of each pickup is made on a common chart in successive, periodic intervals.

Spindle Position Recorder. This instrument is used to report the axial position of the turbine spindle relative to the stationary parts at the thrust bearing. Excessive spindle movements can be caused by high thrust loads or by wear of the thrust bearing shoes. The instrument pickup coils are located close to the thrust bearing so that thermal expansions throughout the turbine do not affect the readings.

Cylinder Expansion Recorder. The cylinder expansion recorder is used to measure the total elongation of the turbine cylinders. Since the turbine is anchored at the exhaust end, the recorder pickup is placed at the opposite or governor pedestal end. The instrument consists of a combination rack and gear that is used to rotate a potentiometer.

Differential Expansion Recorder. Since different parts of a turbine expand at different rates, it is essential that the differential motion between the rotating and stationary parts be known at all times so that proper axial clearances can be maintained.

Speed and Governor Valve Position Recorder. During starting and emergency conditions a record of speed is important. When a unit is on the line, the speed is known to be synchronous and a record of governor valve position is often desirable as a permanent station record.

A combined speed-valve position recorder is available to record speed up to 3550 rpm, governor valve position between 3550 and 3650 rpm and speed above 3650 rpm. Speed sensitive relays select the function to be recorded. THE END

Try Hydraulic Load Cells for Accurate Weight and Force Measurements

These dependable units lend themselves to automatic operation, remote indicating and recording, and serve well in a variety of power field applications. Author reviews their history and future

By MALCOLM C. TATE *

ALTHOUGH IN USE for more than 75 years, hydraulic load cells are experiencing a rebirth in industrial load and force measurement applications: 1, because the instrument industry has achieved tremendous growth in recent years by virtue of intensive research and product development; and 2, because industrial engineers are becoming more convinced that the fundamentally-simple and operationally-sound piston-cylinder theory of force measurement (F = PA) possesses many advantages over complicated electronic devices as well as the relatively inaccurate lever-spring systems.

To handle the thousands of tasks in the current trend toward more automatic operations, industrial engineers have available to them a host of instruments designed for practically any degree of indication, recording, control or printing, or any combination thereof.

These instruments can be obtained to operate from practically any pressure signal . . . hydraulic, pneumatic or electrical. The accuracy of these instruments is absolutely uncanny and they are precision-built to withstand even the roughest industrial use without impairment of a long and satisfactory service life.

More important, perhaps, is the degree of flexibility afforded by newly-developed instrumentation when teamed with load cells. For instance, a platform scale with an attached indicator may weigh a tank satisfactorily, but if it is desirable to locate the indicator 100 ft from the tank, a load cell installation is much better.

Additionally, the signal from a load cell can be used to activate recorders, controllers and even printers, as well as indicators. Since the load cell signal is hydraulic, hydraulic instrumentation can be used to provide an explosion-proof installation. With suitable transmitting equipment, the hydraulic signal can be converted to an electric, or even a pneumatic signal.

It is primarily this flexibility, together with the accuracy of the load cells, which accounts for their newfound popularity.

First load cell for a testing machine was installed as the load-sensing element in a universal testing machine built for the Watertown Arsenal in 1879. See Fig. 1. The capacity of this first load cell was 800,000 lb.

In the acceptance tests conducted at the Arsenal, a forged link of hard wrought iron was broken at 722,800 lb. Immediately, and without adjustment, a horse hair 0.007 in. in diameter was broken at 1 lb and was accurately indicated by the testing machine.

This Watertown Arsenal testing machine has been in continuous service since 1879 and the load cell has performed accurately and satisfactorily during that time.

Partially as a result of the success of the load cell in the Watertown Arsenal machine, the cell became the standard load-sensing device on all the universal testing machines built and sold by the Baldwin-Lima-Hamilton Corporation. The cells are still being used extensively for this service. See Fig. 2.

Operation of Cell is Simple

In effect, the hydraulic load cell is a transducer. It measures force by converting this force into exactly proportional pressures which, in turn, are used to actuate either a suitable indicator, recorder, control device or printer.

Fundamentally, the cell is a specially-designed rigid piston-cylinder assembly. Its operation is shown diagrammatically in Fig. 5, although, for simplification, the cell is not drawn in exact detail, or to scale.

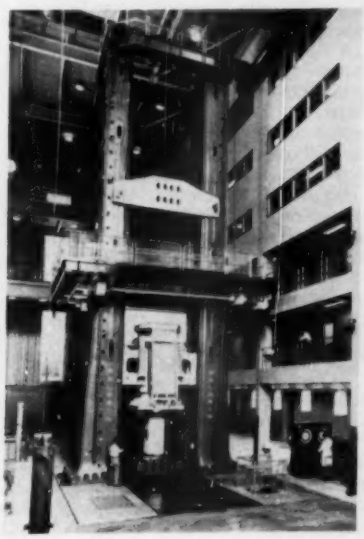
Fundamentally there are two basic types of load cells, the type used for compression, and the type for universal use. The piston is held centrally in the cylinder by a flat annular stayplate and a flat bridge ring. The metal diaphragm seals in a fluid layer not more than 0.030 in. thick.

Upper stayplate is firmly clamped at its inner and outer edges, the fastening bolt passing through the stayplate itself. It is located an appreciable distance from the bridge ring making a stable couple. That is, any tendency of the piston to tip or move sideways is resisted by the upper stayplate at one end and the bridge ring at the other. Being an appreciable distance apart, these parts are better able to resist a turning torque.

Bridge ring has two purposes: 1, to support the diaphragm as it bridges across from the piston to the cylinder; and 2, to provide a means of centralizing the piston in the cylinder. At the same time, the bridge ring withstands a heavy crossload. Since the ring is made with a series of annular slots, it has practically no vertical restraint. It is made of tool steel, cadmium plated for corrosion resistance. A plastic boot protects the working parts from dirt, moisture, and corrosive chemicals or fumes.

In tank-weighing service, or wherever the structure being weighed has a tendency to exert crossloads due to its own expansion or contraction, a modification of the cell is used. (The

*Chief Engineer, The A. H. Emery Company



Figs. 1 and 2. The old and the new. Above, testing machine built in 1879, still in use. At right, 10,000,000-lb universal testing machine at Lehigh U

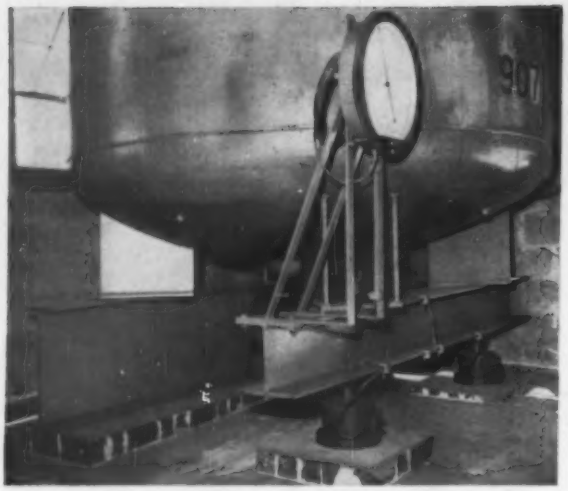


Fig. 3. Typical installation of load cells for determining amount of liquid in tank. Indication may also be remote

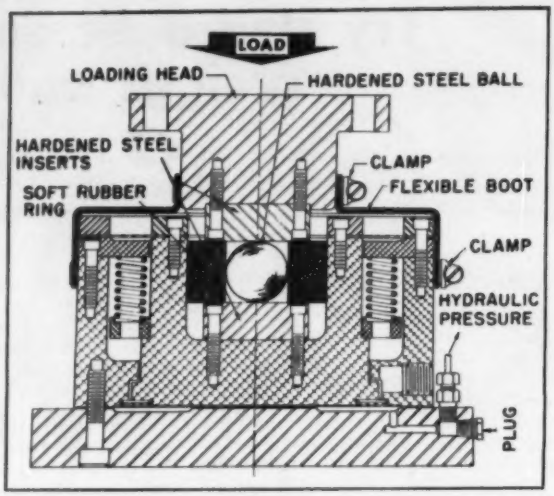


Fig. 4. Cross-section of compression cell with rolling-ball head which allows for expansion of load in horizontal plane

modification known as the "Rolling-Ball Head" (Fig. 4) is exclusive with Emery load cells.) Any load cell which does not take into consideration the natural expansion or contraction of structures being weighed is not properly designed.

In the rolling-ball head, a hardened steel ball is located beneath the loading platform between two hardened steel inserts. This rolling-ball head not only permits the tank or bin to expand or shift sideways, but it also transmits the force to the cell so no deleterious operation results. As the ball rolls, the center of the loading rolls on the hardened steel inserts.

The rolling-ball head allows for any tipping of the surface to which it is attached without exerting any undesirable loading of the cell. It is also self-leveling.

Highly Accurate

Indicator normally used with load cells utilizes a bourdon tube to indicate the pressure from the cell.

A simple response valve in the tube line between the load cell and the indicator isolates the vibration of a vibratory load and controls the response of the indicator. The indicator then shows the mean value of the vibratory loadings.

Load cells are factory-calibrated to an accuracy of better than 0.1 per cent of load range. If the instrumentation to be used with these load cells is carefully selected and applied, a similarly high accuracy may be expected from the entire system.

Versatile in Load Measurement

It is obvious that these load cells can be applied in practically any installation to measure force or load.

These load cells are used for track scales, tank-weighing installations, automatic drum filling, weighing reels of paper, crane scales, airplane testing, and in specialized applications.

Since cells have been produced primarily for capacities ranging upward from 1000 lb, it was recognized that the new concept of weighing rather than measuring would create a demand for cells in the lower capacities.

Therefore, a new series of low-capacity, low-price load cells was developed. Basically similar to their "big brothers", these cells, whose capacities range up to 5,000 lb, feature a long-stroke molded rubber diaphragm as a pressure seal.

Since the consistent acting area of the piston in a piston-cylinder assembly determines the consistent accuracy of the cell, much thought and attention was given to the diaphragm. A unique rolling action of the Emery diaphragm maintains the semi-circular condition of the catenary so necessary for consistent acting area.

Leakage in the hydraulic system is another critical factor in maintaining consistent accuracy. Therefore, the sections of the cells which carry the hydraulic fittings are made from aluminum bar stock to eliminate the possibility of leakage.

Although a cell-plus-instrumentation installation in an industrial plant is usually more costly than a simple lever-scale arrangement, costs must always be predicted on the basis of the job which must be done.

For instance, the functions of recording, control and printing are usually far less expensive when used in conjunction with load cells than when attempts are made to use a simple lever scale as the load-sensing element. In fact, in most cases, these functions cannot be handled by a lever scale at all.

When instrumentation must be remotely located from the weighing site, load cells are usually specified. This is especially true in developing a control function. THE END

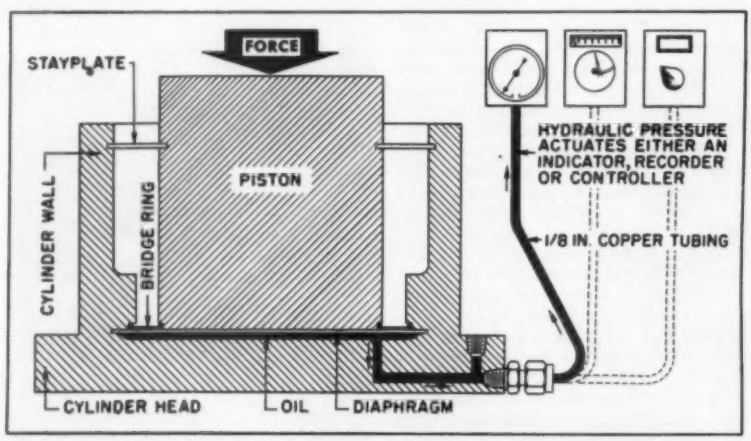


Fig. 5. Functional view of the load cell. Drawing is not to scale or in detail

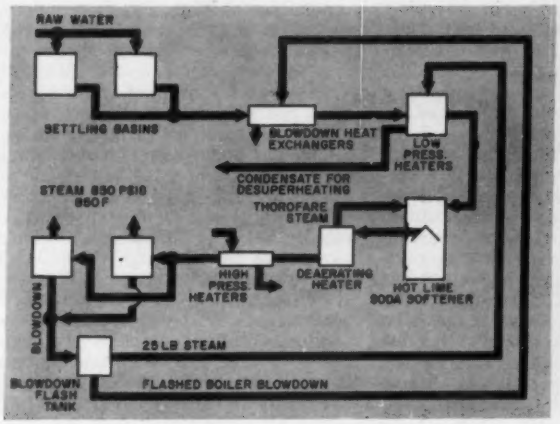


Fig. 1. Schematic showing layout of steam and condensate systems in power plant at National Tube Works, McKeesport

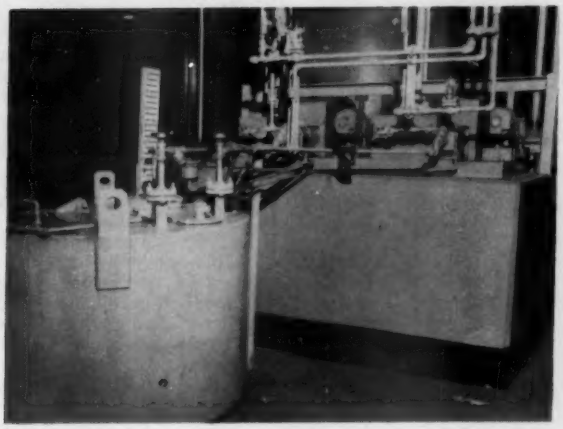


Fig. 2. Filming amine is mixed in tank. Dry product added to tank is mixed with condensate. Pumps (r) distribute mix

Filming Amine Solves Tough Corrosion Problem for Make-Up System

By M. E. OSMOND* and B. Q. WELDER†

WHEN it was proposed at the National Works, National Tube Division, U. S. Steel Corporation at McKeesport, Pa., that a power station be built to produce a million pounds of steam per hour using 100 per cent Monongahela River water as make-up, there was much head-shaking — especially over the pressure of 850 psig. It was recognized by all concerned that the water treatment program would necessarily be rigorous. As a result, practically all problems inherent in such a setup were anticipated and no extended outages due to water problems have occurred.

There was one problem that was anticipated but for which there was no completely satisfactory answer at the time the installation was planned. This was corrosion in the system which condensed 25-psi flashed steam from the blowdown tank to provide condensate for desuperheating. Since the make-up water for the boilers was to be lime-soda softened, the condensate would contain an appreciable amount of dissolved carbon dioxide and would be extremely aggressive. Nevertheless, there was no easy solution because the high carbon dioxide concentration would result in an astronomical cost for neutralizing amine treatment. In view of this, a wait-and-see position was adopted.

Schematic layout of the steam and condensate systems in this plant is shown in Fig. 1. Raw water comes from the Monongahela River water and fluctuates widely in composition not only from season to season and from day to day but actually from hour to hour. Dissolved solids can vary from 400 ppm to 1000 ppm, suspended solids from 25 ppm to 1500 ppm, hardness from 75 ppm to 350 ppm and pH from 3.5 to 6.5. Controlling the pre-treatment of such a water to provide 100 per cent make-up for 850-psig boilers obviously requires a stout heart and a clear head.

The raw river water is first clarified in settling basins with a Hagan coagulant aid and alum. Clarified water passes through a blowdown heat exchanger and then goes through two low-pressure heaters supplied with 25-lb steam from the blowdown flash tank. Next step is lime-soda softening. Because of the high blowdown rate resulting from the high dissolved solids concentration of the raw water, it is possible to carry a relatively high concentration of soda ash in the softener effluent without having unusually high alkalinity readings in the boiler water. This results in excellent hardness reduction in the softeners. As a matter of fact, the effluent from the filters following the softeners has an average hardness of 0.1 gpg.

The treated, filtered water is deaerated and passed through two high-pressure heaters. It then reaches its destination, Combustion Engineering boilers producing 175,000 lbs of steam per hour each at 850 psig. During normal operation the steam is used in 150-psi back pressure turboblowers. In parallel with the turboblowers are three desuperheating and pressure-reducing stations which alter the steam conditions to 420 F and 150 psi.

Condensate for operating these desuperheating stations is supplied from the two low-pressure heaters previously mentioned. Actually, the low-pressure heaters probably could more correctly be described as condensers, because their primary function is to supply desuperheating water. They produce about 500,000 lb of condensate per day including spillover to the deaerating heater.

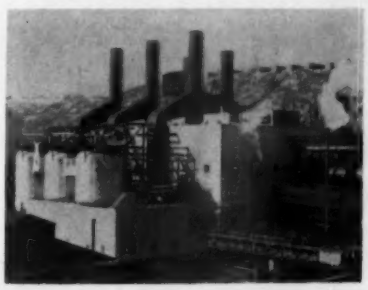


Fig. 3. National Tube's power plant produces 1,000,000 lb of steam per hr using 100% river water for make-up

Anticipated difficulty with corrosion in the desuperheating condensate system developed after several years of operation. The low-pressure heater shells were badly corroded. Repairs required extensive patching by welding. Corrosion of fittings in the spillover system and piping from the condensate storage became extremely serious. Schedule 40 fittings corroded through in a matter of weeks. Progressively the plant went from schedule 40 fittings to schedule 80 fittings and eventually to schedule 160 fittings. Even the last corroded through in three months or less.

Development of filming amine of-

*Field Engineer, Hall Laboratories Div, Hagen Chemicals and Controls, Inc; †Head of Boiler Chemical Sales, same company

fered a solution to the problem. Hall Laboratories engineers recommended its use. An unused acid-feeding setup could be employed to feed it. A line was run from the discharge of the chemical feed pumps to the 25-lb steam header ahead of the low-pressure heaters. Treatment with Hagafilm was started at the feed rate of 4 ppm and was reduced in about a month to 2 ppm.

Corrosion rate prior to Hagafilm treatment was almost unbelievable. Standard 1 by 2 by 20-gage carbon steel panels installed in the desuperheating condensate system pitted through in 24 hours. Corrosion rate was on the order of 1285 mg/dm²/day. To determine the optimum treatment, the correlation between Hagafilm feed and reduction in corrosion was studied. It was found that the corrosion rate could be reduced from the 1285 mg/dm²/day level with no treatment, to less than 1 mg/dm²/day with 4-ppm feed, and to a range of 5 to 10 mg/dm²/day with a 2-ppm feed. Present practice is to feed at 3 ppm.

Results with filming amine treatment have been truly remarkable. In the spill-over system, where failures of fittings and lines were occurring weekly and monthly prior to treatment, there have been no failures in almost four years. Corrosion of the low-pressure heater shells has been arrested. Before treatment, the discoloration of the sight glasses on the condensate storage tanks with corrosion products was so severe it was impossible to determine the condensate level in the tanks. The sight glasses are now clean and the condensate is water-white and sparkling. Needless to say, filming amine treatment has paid for itself many times over in reduced cost of maintenance.

This particular case is phenomenal because of the severity of the corrosion. There are a great many other plants where results are not so spectacular but where filming amine has more than paid its way by reducing corrosion in heating plant condensate systems and process condensate systems as well. With proper application of filming amine, corrosion problems due to oxygen and/or carbon dioxide in condensate should become as obsolete as the horse and buggy. THE END

New Process Makes Lightweight Aggregate From Molten Boiler Slag

Fig. 1. Particles of Dowlite passing a 100-mesh screen. Photo enlarged 75 times. Note uniformity of structure

DOW CHEMICAL reports a new process by which molten slag from wet bottom, slag tap boilers is made into lightweight aggregate suitable for use in concrete masonry units, preformed concrete building wall and roof sections, and in lightweight concrete.

Dow already has the process in operation at its South Power House in its Midland, Michigan, plant and has marketed the aggregate locally on a limited scale for use in the manufacture of lightweight concrete blocks.

The company plans to license the process to utilities or other firms with suitable slag tap boiler installations. Adaptability of the process in an existing installation depends primarily on space available. Existing local market for lightweight aggregate helps determine economic feasibility.

Capital investment involved in the new Dow process includes a slag conversion unit and necessary conveyors plus crusher, screen, storage, and handling facilities if desired. Based on the current average selling price for slag aggregate, it is estimated that the average utility could expect a return on capital investment in five years or less.

Aggregate produced by the process at Midland has been trademarked Dowlite. It is an iron aluminum silicate aggregate that exhibits both light weight and strength characteristics as well as good free-flow qualities in block machines.

It has the appearance of black glass when cold and is designated as amorphous. The aggregate is inert and contains no unburned combustible material. Its inert characteristics prevent "popouts" which can occur in blocks made from aggregates containing unburned refuse.

Slag is melted boiler ash resulting from the combustion of coal. This is processed to produce what is known in the trade as expanded slag. Crushing and screening gives a mineral aggregate in two sizes — coarse, which will pass a No. 2 mesh and be retained on a No. 4 mesh; and fine, which will pass a No. 4 mesh — both conform to ASTM specifications C-331-53T.

Crushed Dowlite is angular in shape with a minimum of flat or elongated particles. Cellular structure is uniform throughout and is evident even in particles which pass a 100-mesh screen.

An 8 by 8 by 16-in. concrete block made from Dowlite using a mix of one part cement, two parts coarse and three parts fine, weighs from 26–30 lb and has a 28-day compressive strength of about 1300 psi. This meets Class-A masonry block specifications.

The lightweight aggregate block produced has a pleasing soft grey color, a result of cement binder which coats the individual particles. Blocks have shown very good color stability.

Dow has a continuing testing program in progress to explore all possible uses for the new expanded slag in the construction field.

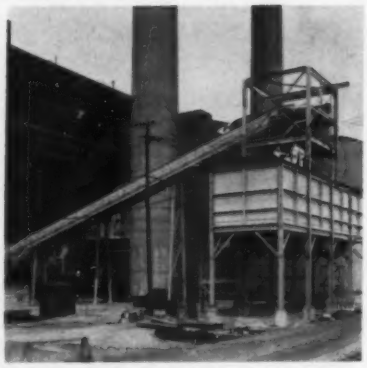


Fig. 2. Lightweight aggregate installation at Dow's South Power House, with storage bins and conveyor nearing completion. Crusher and vibrating screen are located above the 4 storage bins

Fig. 3. Though Dowlite aggregate is black, block is a soft grey in color

Coming to the Power Conference in Chicago?

Meet us in POWER ENGINEERING'S hospitality suite in the Hotel Sherman—for refreshments, a rest, conversation with new friends and old. We welcome you between or after sessions, 11 A.M. to midnight. Ask the hotel reservation desk for our room number

American Power Conference Opens March 31

FOR THE THREE DAYS of March 31, April 1 and 2, power engineers from all parts of the country will converge on Chicago, where the 21st annual American Power Conference is being held in the Hotel Sherman. Program this year is all-inclusive as ever, with a rich variety of special interest sessions.

Conference opens on Tuesday, March 31, at 10 A.M., under the chairmanship of Dudley Sanford, executive vice president of the Union Electric Company, and will be addressed then by Murray Joslin, vice president of Commonwealth Edison Co and by W. F. Rockwell, Jr., president of Rockwell Mfg Co. The joint APC-ASME luncheon occurs that same day, with J. E. Corette, president of the Edison Electric Institute, as speaker.

Tuesday evening features an exchange of thought on the prospects for direct conversion of heat into electrical energy and for achieving electric power from fusion. Chairman for the evening is POWER ENGINEERING'S Andrew W. Kramer, formerly editor of the magazine and now editor of the ATOMICS section. Perry L. Blackshear, Jr, of the University of Minnesota will serve as co-chairman, and two speakers will lead off a general discussion. These speakers are John C. R. Kelly, Jr, of the Westinghouse Research Laboratory, who will present the situation today for direct conversion of heat to electricity; and Leonard J. Linde, of Allis-Chalmers and RCA, who will speak on thermonuclear fusion research for power.

Wednesday morning's general session (April 1) offers a symposium on once-through boiler plants for subcritical pressure, under the leadership of Ben G. Elliott of the University of Wisconsin. The AIEE luncheon follows this meeting, with Earl L. Butz, Dean of Agriculture at Purdue, as speaker. The All-Engineers dinner comes Wednesday evening. Herbert D. Vogel, TVA's chairman of the board, will address the conference at that time.

Luncheon sponsored by the Western Society of Engineers is scheduled for Thursday.

Following is a summary of subjects that will be presented in the many special group sessions during the three days of the conference:

Steam Turbines: Ultrasonic Testing of Large Steam Turbine Parts, by M. L. Smith; Progress in Steam Turbine Generator Research and Development, by J. W. Stotts and J. K. Dixon; Large Steam Turbine Generators for the 60's, by E. H. Miller and B. M. Cain; Advance Development in Component Design for Large Steam Turbines, by R. Reese.

Extra High Voltage Systems: The 300-Kv System, by H. W. Haberl; The 345-Kv System, by E. A. Rothfus; Extra High Voltage Cable — Challenge of the Future, by C. S. Schifreen.

Water Technology — Ion Exchange: Two-Bed Primary System Solves Mixed-Bed Demineralizer Problems, by H. C. Farmer; Experience with an Improved Intermediate-Base Anion Exchange Water for Problem Waters, by I. M. Abrams, R. J. Cooley, and G. F. Stoneman; Filtration of Condensate as a Part of the High Rate Condensate Scavenging Process, by W. H. Homer and V. J. Calise; High-Flow Rate Ion Exchange, by Joe Thompson and A. C. Reents.

Water Technology — Analytical and Control: A New Method for Continuous Analysis of Dissolved Oxygen and Water, by J. M. Wright and W. T. Lindsay, Jr; A New System for the Completely Automatic Chemical Analysis of Boiler and Condensate Waters for Power Plants.

Water Technology — Condenser Tubing Alloys: Stainless Steel Condenser Tubes — Four Years' Experience, by John C. Cokley, Jr.; Experience with Aluminum Condenser Tubes.

Stress Corrosion of Stainless Steel and Boiler Water Treatment, Shippingport Atomic Power Station, by W. J. Singley, I. H. Wellinsky and S. F. Whirl. Also, there will be a session on Industrial Water.

Fuels: Evaluation of Coal Sampling Procedures, by W. W. Anderson; Producing Lightweight Aggregate from Molten Boiler Slag, by Howard L. McNally; Generating Station Coal Bunker Explosions, by W. W. Hagnauer and K. W. Hamming.

Hydroelectric Power — Review of Policies: The Federal Power Commission-Licensing Procedures and Regulations Under the Federal Power Commission; Example of Hydroelectric Development by a Private Utility, by H. Neely Henry; Policies in Cost Estimating, Earnings Analysis and Financing, by P. P. Stathas.

Hydroelectric Power — Current Developments: Hydro Potentialities as Indicated by the Federal Power Commission, by Frank L. Weaver; Hydroelectric Projects and Future Program of the Corps of Engineers, by Brigadier General John L. Person; Developments and Sale of Hydroelectric Power by the Bureau of Reclamation, by W. A. Dexheimer. Hydro potentialities for the various regions of the U. S. will be discussed.

High Voltage Transmission: Experience with High Voltage Twin Conductor Lines, by N. H. Erlandson; A 34.5-Kv Polyethylene Insulated Cable Installation, by G. J. Crowdes.

Central Station Power Plants: The Second Year's Operation of a Supercritical Unit, by T. T. Frankenberg and E. B. Morris; The Evaluation of Automation for Central Station Power Plants, by F. A. Ritchings and W. A. Summers; Which Enclosure Shall It Be? by C D. Birget.

Control of Generation on Interconnected Systems: Operating Experience with an Automatic Dispatching System, by H. H. Mochon; Coördination of a Desired Generation Computer with Area-Wide Generation Control, by N. E. Brown, Harry Fereshetian and M. D. Liechty; Operating Experience with a Command-Type Load Frequency Control System, by W. D. Wilder.

Steam Generators: An Operating Report of the Monitored Sterlington Station, by Donald Aswell and George Parmakian; Control System for Achieving Optimum Boiler Economy in a Single Unit Simultaneously Burning Three By-Product Fuels, by W. O. Barnett; Gas Recirculation and Its Relation to Boiler Design and Operation, by J. D. Andrews, A. M. Frendberg and P. H. Koch; Mechanics of Corrosion in High Temperature Superheater and Reheater Tubes, by Edward M. Marcelli and Richard C. Ulmer.

Industrial Plants: Industry Viewpoint, by R. W. Precious; Industry Viewpoint, by R. H. Emery; Turbine Manufacturer's Viewpoint, by C. E. Ferson; Boiler Manufacturer's Viewpoint, by C. E. Miller; Consulting Engineer's Viewpoint, by J. A. Donald. *continued on page 104*

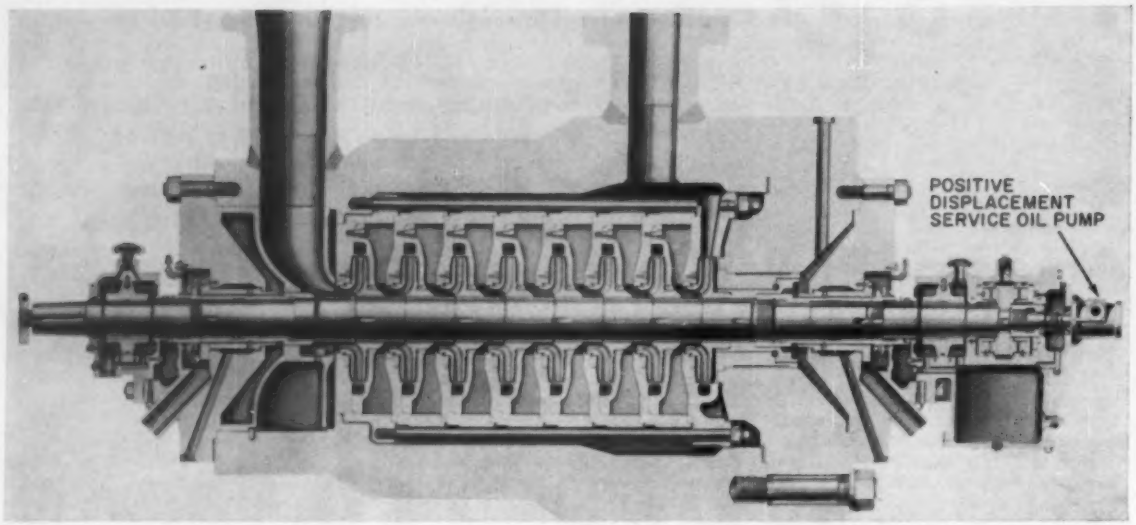


Fig. 1. Section showing system of forced-feed lubrication by positive displacement pump driven by boiler feed pump shaft

Watch Lube Oil Characteristics in Boiler Feed Service

By IGOR J. KARASSIK*

OPERATION OF HIGH PRESSURE boiler feed pumps requires that careful attention be paid to many details. Failure to give full consideration to these details can easily introduce serious problems and costly maintenance. Even greater costs are incurred if these problems lead, as they can, to interruption of service. It is seldom that such difficulties can be directly traced to the use of improper lubricating oil or to appreciable deviations from the required oil temperatures. Yet, since such difficulties do occur and can cause considerable damage, it may be useful to relate in some detail a recent case which came to my attention and which took some time and effort to straighten out.

Installation in question consisted of two full-capacity high pressure boiler feed pumps, driven by 1750 HP, 3575-rpm motors. One pump serves the unit and the second pump is held on standby duty. Pumps incorporate a Kingsbury thrust bearing and sleeve-type line bearings with forced-feed lubrication provided by an Imo-type positive displacement pump driven directly from the pump shaft as shown in Fig 1. In addition, the lube system incorporates an auxiliary oil pump of the gear type, mounted vertically over the oil tank in the baseplate and driven by a 1 hp 1725-rpm electric motor. Complete oil lubrication system is shown diagrammatically in Fig 2.

Service oil pump delivers lubricating oil through a duplex oil filter and a vertical tubular cooler into a header from which supply connections are made to the pump thrust bearing, the pump line bearings and the two motor bearings. Oil returns from all these bearings to a sump in the pump baseplate. Auxiliary oil pump delivers oil in parallel with the service pump, check valves being provided at the necessary points in the respective discharge lines to prevent reverse flow through an idle pump and back into the sump.

Two oil pressure switches are located in the circuit. The first of these is the switch for the main motor starter interlock, set so that the main motor switch contact closes at 15 psi and opens if the pressure falls to 10 psi. It also incorporates an alarm contact which closes at 10 psi and opens at 15 psi. The second switch controls the operation of the auxiliary oil pump, stopping it whenever the oil pressure reaches 18 psi and restarting it when the oil pressure falls to 12 psi. In addition, the lube system incorporates the necessary oil pressure gauges and thermometers. Finally, a relief valve set at 20 psi

*Consulting Engineer and Manager of Planning, Harrison Div, Worthington Corp

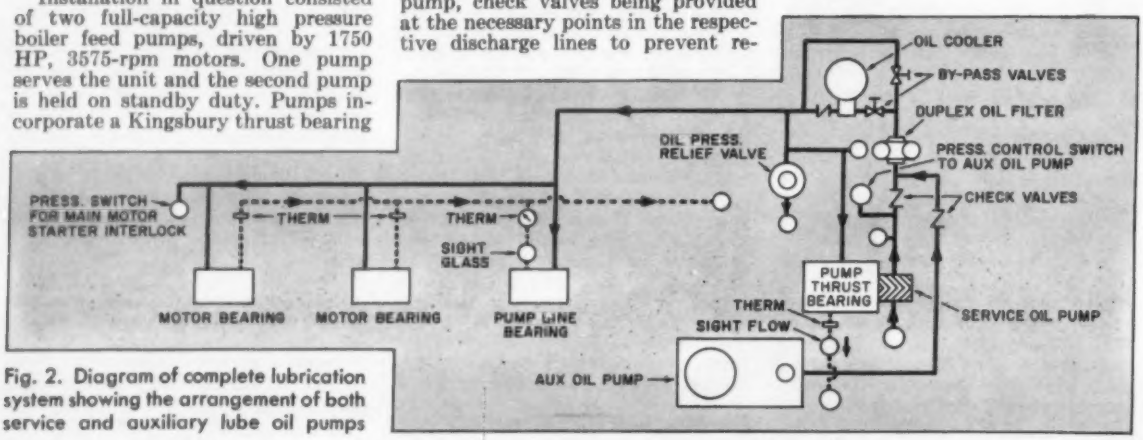


Fig. 2. Diagram of complete lubrication system showing the arrangement of both service and auxiliary lube oil pumps

is located in the discharge from the oil cooler.

Accurate Specifications Needed

Pump specifications submitted to the pump manufacturer had stipulated that the cooling water to be used in the oil coolers would be at 100 F. When oil piping diagrams were submitted to the customer for approval, the required quantities of cooling water were indicated thereon and instructions were applied to use oil of 250 SSU viscosity at 100 F. Operating temperature has a great deal of effect on oil viscosity, as can be seen from Fig 3. Thus, if oil rated at 250 SSU at 100 F is used, it will have a viscosity of about 150 SSU at a temperature of 120 F, which is approximately the temperature obtainable at the exit from an oil cooler operated with 100 F cooling water. If the exit oil temperature deviates appreciably from 120 F, the cooling water supply must be readjusted to obtain the desired oil temperature.

This recommendation is based on the following facts:

1. Kingsbury bearings are rated for thrust load capacity at an operating viscosity of 150 SSU. Viscosities much lower than this will therefore reduce the thrust capacity of the bearing.

2. If, by virtue of oil temperatures much lower than recommended, the operating viscosity increases appreciably above 150 SSU, power consumption of the auxiliary oil pump motor will increase to a point where serious motor overload can take place.

3. If oil temperatures are permitted to fall to 70 or 60 F, for instance, not only will the viscosity increase excessively, but danger exists that moisture condensation will take place in the oil system and water will start accumulating in the oil tank.

Wrong Oil Overloads Motor

Very shortly after the installation and initial operation of these pumps, I was advised that serious operating difficulties were encountered. Whenever it was desired to switch pumps and put the standby pump on the line, the operating sequence would start up the auxiliary oil pump. Immediately, the motor driving this pump would become overloaded by as much as 100% and the thermal overload protection relays would kick the motor off the line. Thus, it was impossible to get the main motor of the standby pump started since its starter was interlocked in such a manner with the oil pressure switch that failure of the auxiliary oil pump to provide adequate pressure prevented the starter from functioning. Conclusions reached by the operators were that the motor driving the auxiliary oil pump was inadequately sized and judging by the amount of overload involved should be replaced by a 3-hp motor.

An on-the-spot investigation disclosed several important discrepancies between the recommended oil characteristics and temperatures and the values recommended. In the first place, an oil with 300 SSU viscosity at 100 F was used. Fact that contributed most heavily to the overload condition, however, was that the oil temperature leaving the oil cooler ran to as low as 75 F during the daytime and less than this at night when the ambient temperature was lower. (This is an outdoor installation with cooling towers and therefore the cooling water supply is directly affected by ambient temperatures). If reference is made to Fig 3, it will be noted that viscosities of the oil may run as high as 1000 SSU under these conditions. Effect of such high viscosities on the auxiliary oil pump motor power consumption is obvious.

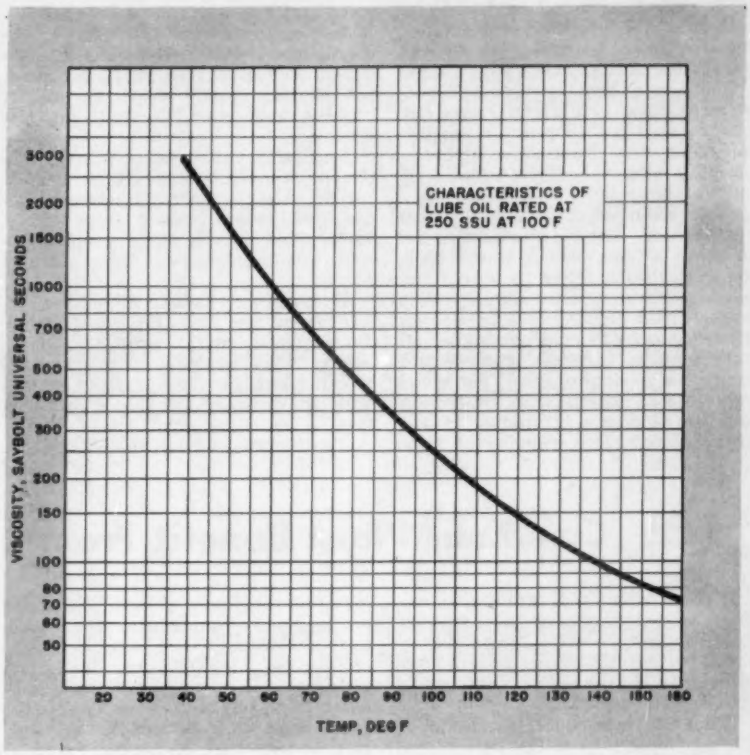


Fig. 3. Graph showing how the viscosity of oil varies with temperature change

Outdoor Installation a Factor

Discussions with the operators disclosed that 250 SSU oil at 100 F was not readily available and an immediate decision to permit using 225 SSU oil was reached. Question of temperatures, however, was a different matter. It developed that the specifications had mentioned a 100 F cooling water temperature in order to be sure that size of the oil cooler would be adequate. Cooling water was to come from the well supply and would be at about 75 to 80 F. the year around.

There was another problem that we could readily see facing us: even disregarding the cooling water temperature, the outdoor installation would cause oil temperatures in the oil sump of the standby pump to fall to the 40–50 F ambient in winter nights. Should the standby pump be called upon to start under these conditions the resulting overload on the auxiliary oil pump motor would kick this pump off the line immediately upon starting and prevent bringing the standby pump on the line. The operators, therefore, were extremely insistent on replacing the auxiliary oil pump motor by a larger unit — possibly as large as 5 HP. However, even a 5 HP motor would not do the job with 40 F oil, when the viscosity would reach as high as 3000 SSU! In addition, operating the lubricating system under such conditions was absolutely unthinkable. Cold oil would in time pick up moisture from condensation which would eventually lead to bearing failures. It was finally agreed that a larger motor was not only unnecessary but that serious troubles would eventually result unless oil temperatures were kept to reasonable values.

Before reaching a permanent solution, it was necessary to provide temporary means to permit operation of the standby pump without the danger of being shut down by the thermal overload protection of the auxiliary oil pump motor. Overloading of the auxiliary oil pump motor during start-up was due to excessive pressure drop through the filter and cooler when the oil was cold at start-

up. Some means, therefore, had to be introduced for limiting the discharge pressure (and therefore power requirement) of the auxiliary oil pump.

This could best be accomplished by means of a ¾ in. relief valve cut into the auxiliary oil pump discharge line before the check valve and discharging into the oil reservoir. Of course, this relief valve would only operate when the auxiliary oil pump was running. The valve would be set at about 40 psi, which would limit the motor horsepower to within the rated conditions. Flow through this valve would be about 5 to 6 gpm when the oil was cold. At higher oil temperatures, the relief valve would dump little or no oil. This relief valve would also act as protection for the auxiliary oil pump in the event of complete clogging of filter or cooler. There would be no chance of damage to the bearings under these conditions, because the low pressure cut-off switch located at the far motor bearing would trip the main breaker and take the unit out of service.

This relief valve was installed and the oil changed to 225 SSU at 100 F rating. After proper adjustment of the relief valve, motor amps were maintained at the rated conditions and the problem was temporarily solved.

It remained, however, to find a permanent solution for the conditions which would prevail during winter when ambient temperatures would introduce the hazard of moisture condensation in the lube system.

Two solutions were readily available to the operators:

1. The auxiliary oil pump could be operated continuously on the standby pump. This will keep the oil in the reservoir up to reasonable temperature by virtue of the heat delivered to the oil from the auxiliary oil pump itself and the heat picked up by the oil in its flow through the boiler feed pump bearings. These latter are heated by conduction from the pump which is kept warm by circulating hot water through it.

2. Thermostatically controlled immersion type electric heaters could be installed in the oil reservoir to maintain it at a desired temperature.

The first solution was finally adopted and the installation has been operating satisfactorily since these various changes have been incorporated. THE END

Can Your Plant Benefit From a Multi-Fuel Boiler?

TWO DEFINITE and clearly defined influences appear to have triggered a positive trend to multi-fuel-fired boilers. Particularly does this hold true in the small to medium size industrial plant.

First of these is an extension of the age-old fight, on the part of the power engineer, to hold the line on operating costs. Of equal importance to the changing scene is the increasing availability of more than one major fuel, on a competitive basis in practically all parts of the U. S.

As C. F. Hawley of Riley Stoker Corporation pointed out recently in a paper before the National Power Conference, areas of high fuel cost usually have more than one fuel which can be justified economically. This has not always been the case, as witness the situation in Florida where, for many years, oil was the only fuel and at a relatively high cost. Now both gas and coal are competitive with oil, and at least one major utility has invested heavily in coal burning equipment to produce approximately 400,000 kw in one station. California has been in a similar situation with oil as the only fuel; now natural gas is competitive under certain conditions. Even Louisiana, long the stronghold of natural gas, today faces the competition of coal because of the steadily rising cost of gas.

New England, long classified as a high-fuel-cost region, is another example of competition between two high-cost fuels and a third, natural gas, has recently made inroads into the electric utility scene. Prices of coal and oil have been subject to considerable fluctuation over the past decade and there have been periods when first one and then the other held decided price advantage. Plants equipped to burn either fuel efficiently have made substantial fuel savings over a period of time. Hawley quite logically places emphasis on the word *efficiently* and points out that too many plants are designed on the basis of one fuel, with the possibility of burning another in an emergency, but not efficiently. There have been long periods within the past decade when such a plant would have lost a substantial saving.

Efficient and economical use of more than one fuel in the past has involved considerable additional investment for the second fuel. Today, however, boilers are available that have been designed to minimize this additional investment and provide for the efficient use of a variety of fuels. As Hawley observed, these designs are based on providing a furnace which requires no expensive alterations when changing from one fuel to another. Nature of the combustion obtainable is such that the same furnace performance is available with different fuels. Consequently the same range of steam temperature control is possible without costly auxiliary equipment.

Designers problems, when designing for two or more fuels, begin with the furnace, continue with the superheater and proceed through the unit to the air heater gas discharge. Maintenance of steam temperatures over an economical range requires care in selection of the amount and disposition of superheater surface. Amount of required surface varies with the different fuels and is usually least for natural gas and highest for oil, with coal falling in between. Hawley points out that there might be no economy resulting from operating with a second cheaper fuel, such as oil, if the superheater surface has been designed for coal. This is due to the fact the resulting lower steam temperatures would tend to offset any saving. It is essential that the unit be designed for approximately the same temperature range with all available fuels. This problem is simplified by use of intermediate radiant surface in the form of a platen superheater in the furnace.

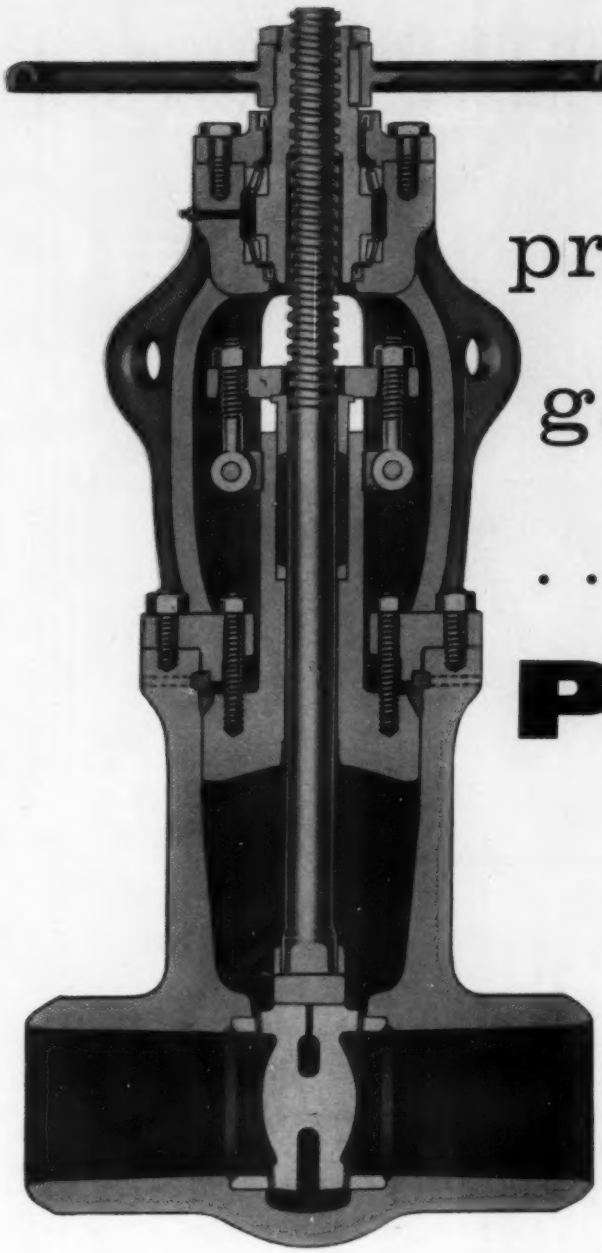
To many a hard-pressed power engineer in high-fuel-cost areas, the possibility of adding multi-fuel capacity to circumvent fluctuations in price of first one fuel and another may be just the ticket to lower overall operating costs. THE END

Lucas Graphs Still Available

IN THE September 1958 issue of POWER ENGINEERING we published an article entitled Figure Your Power Lines Quickly and Accurately with Lucas Graphs. That article described, with typical examples, a set of graphs that probably constitutes one of the most important contributions to time-saving in the whole field of transmission and distribution power line calculations.

We have distributed hundreds of copies of the Lucas Graphs to readers who requested them, but now our supply of free copies is completely exhausted. However, we are having a second printing made and can supply copies from now on at $1 per set, with quantity prices on request.

Write the Editor of POWER ENGINEERING, 308 E. James Street, Barrington, Illinois.



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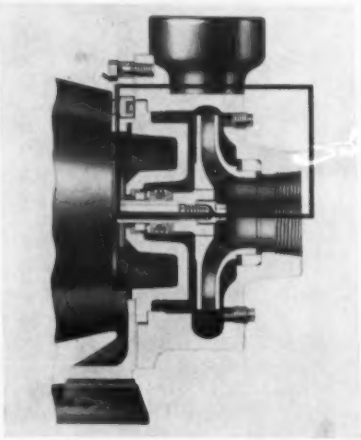
Power Engineering handbook

How to Maintain Centrifugal Pumps



5—Wearing Rings

Begun in October, 1958, this series has appeared in the Handbook of November, 1958 and January and February of this year. Covered thus far: stuffing boxes fitted with packing; stuffing boxes that have mechanical seals; shafts and sleeves; the impeller. Chapter 6 will be on bearings used in pumps

By J. A. CABLE * and
O. M. KRISTY, Jr.*

Fig. 1. Cross section of typical single suction pump with only one casing ring, press fitted

LAST TIME we discussed the selection of proper impellers; but impellers can't do you any good without close clearance fits which will keep them performing efficiently. This point of close clearance occurs where the casing suction passage is adjacent to its discharge passage as the casing surrounds the impeller. Without this close clearance, the pressure developed by the impeller would escape back to the lower pressure area on the inlet side.

This internal recirculation must be kept to a minimum if your pump is to operate efficiently. Not only must you start out with minimized recirculation, but the better this condition is maintained, the better will be the resulting performance. These close clearances could feasibly be accomplished on new pumps without wearing rings. However, wearing rings provide a means of renewing close clearances without the much more expensive replacement of impeller and casing.

There are two kinds of rings, those that fit into the casing and those mounted onto the impeller hub. The first are called casing rings and these are included in almost all pumps of quality construction. Since the casing is usually the most expensive part of the pump, protecting it with these rings is an economical necessity. Impeller rings are usually not standard equipment with single suction pumps or many small-size double suction pumps. Many pump manufacturers do make them available as nominally priced modifications for these pumps, and starting at around a 6- or 8-inch size the impeller rings become standard equipment on double suction pumps.

* Application Engineer and Supervisory Engineer, respectively, Centrifugal Pump Dept, Allis-Chalmers Mfg Co

fold along this line—outside edges toward you

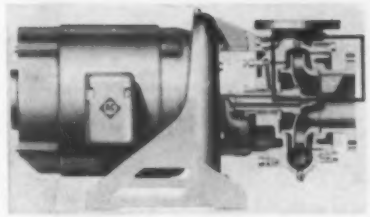


Fig. 2. Larger single suction pump with two casing rings. Second reduces stuffing box pressure as leakage past this clearance returns to inlet side of the impeller through balance holes

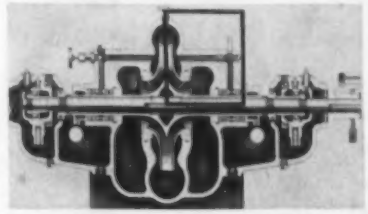


Fig. 3. Larger double suction pump with both impeller and casing rings. Rings are usually bronze

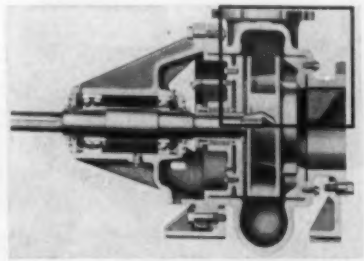


Fig. 4. Special purpose slurry handling pump which has axial clearance adjustable rings

Materials

Standard rings are usually bronze with two different hardnesses used when both casing and impeller rings are included. For tougher services such as occasionally dirty water, rings of 12 to 14 chrome steel hardened to 400 to 500 Brinell are advisable. These hardened rings are also better when pump handles hot water over 212 F. These are often pinned in place on the impeller hubs to prevent rotation.

When to Replace

With radical clearances as in Figs. 1, 2 and 3, get the manufacturer to tell you original clearances. If drop-off in performance cannot be checked, inspect clearances and replace the rings when clearance triples original dimensions. Axial clearances as in Figs. 4 and 5 should be routinely checked and adjusted. Do not let them get too bad or wear will concentrate at localized points and make premature parts replacement necessary.

Be good to your wearing rings by making sure that the pump is always

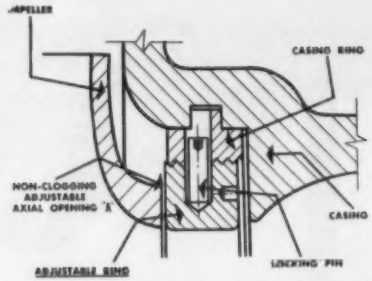


Fig. 5. Special adjustable wearing rings with axial clearance designed for double suction pumps

cut along this line

KEELER **dk** package steam generators

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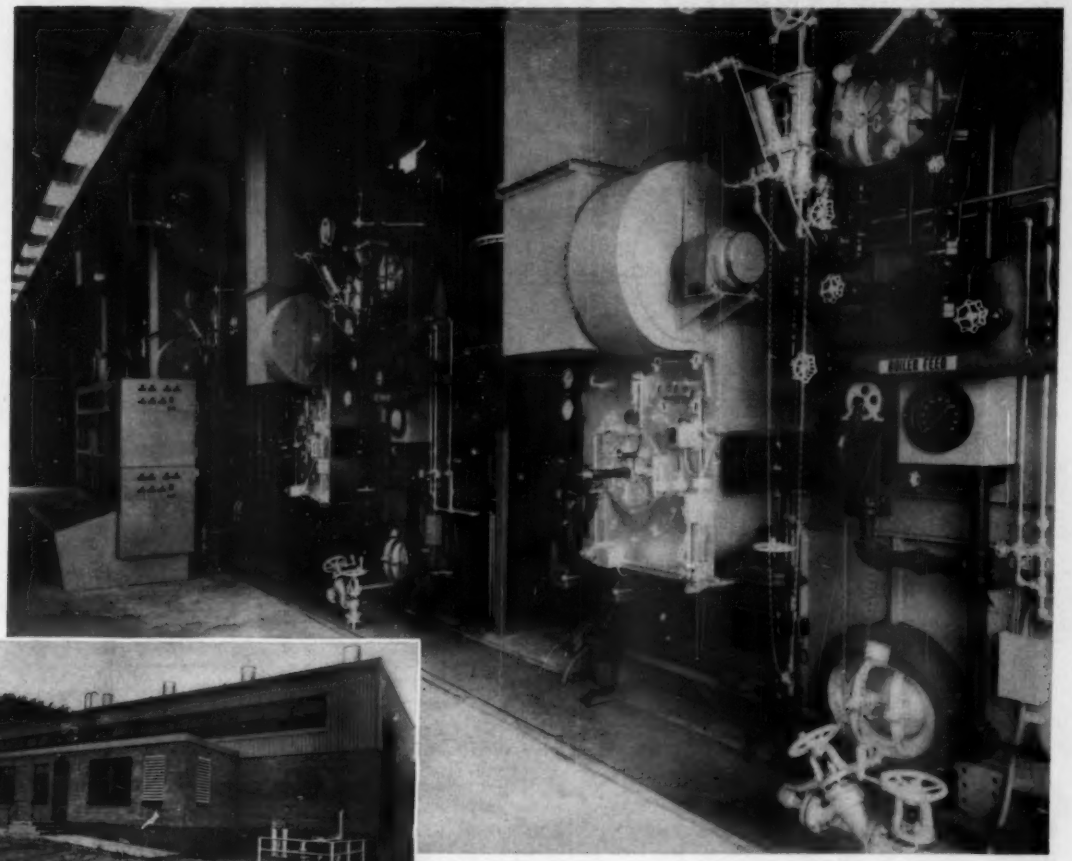
U. S. Government Indian School operated by
United States Department of the Interior, Bureau of Indian Affairs
Washington, D. C.
Arthur O. Allen, Engineering Advisor



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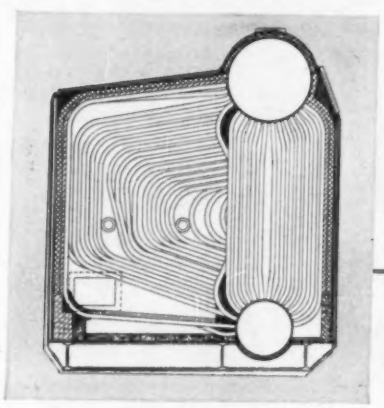
BUREAU OF INDIAN AFFAIRS, BRANCH OF PLANT DESIGN & CONSTRUCTION, ALBUQUERQUE, N. M.
Edward A. Poynton, Chief



With an eye for economy and efficiency, the new central heating plant at the Haskell Institute is equipped with four multi-purpose Keeler Type D K package steam generators. They supply the entire steam needs of the several buildings at this U. S. Government Indian School located on a 280-acre tract near Kansas City.

Three of the units are 25,000-lb stm/hr capacity boilers equipped for combination oil and gas firing, and the fourth is an 18,000-lb stm/hr gas-fired unit.

A *"better efficiency than required"* report confirms the wisdom of the selection, together with further statements which indicate *a 20% drop in fuel costs*, when firing the new Keeler Type D K units at the same capacity as the previous equipment.

There's a size and type Keeler steam generator available for your requirements—up to 200,000-lbs stm/hr—with the full economy, efficiency, versatility and dependability that has earned Keeler its reputation as "builders of better boilers since 1864"! *Write or phone for free bulletins, full data and specifications . . .*

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KEELER WATER TUBE Boilers

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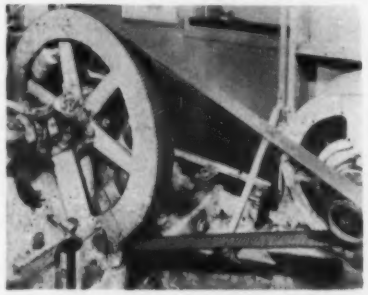
Application of pump types shown in the figures (preceding page), with directions for ring replacement

	Application	How Rings Are Replaced
Figure 1	Clear liquids	Cut out old rings with cold chisel. Install new ones with temperature change device, either sub-cool ring with dry ice or heat casing with torch.
Figure 2	Clear liquids	Cut out old rings with cold chisel. Install new ones with temperature change device, either sub-cool ring with dry ice or heat casing with torch.
Figure 3	Clear liquids	Casing rings held in place either by interrupted tongue-and-groove fit in casing, or close fit with pin to prevent rotation. Impeller rings if shrunk on: cut off old ones, cold chisel, heat new ones before sliding one. Some are threaded in place, so screw off.
Figure 4	Solids-laden liquids	Front ring, usually called "side plate," bolts through casing wall. Back plate bolts through suction cover wall. Front clearance most critical and pump bearing bracket arranged for axial adjustment.
Figure 5	Liquids with small percentage (2 per cent or less) solids	Stationary ring locks in casing with interrupted tongue-and-groove. Inner ring threads into outer and is locked by drop-in-pin which is removed when adjusting and then redrilled with new lock pin hole.

primed every time it starts up and runs. The liquid pumped has to act as a lubricant in these clearances, for if run dry, rubbing metal will quickly overheat and seize the rubbing surfaces. This can do major damage to more parts than just the rings, such as twisting off of shafts, etc.

One last word of caution in connection with wearing rings concerns casing gaskets in double suction pumps. Be sure the proper gasket thickness is used for replacement purposes because too thick a gasket will leave room for water or other pumped liquid to flow around the outside of the casing rings. This can rapidly cut both the ring and its fit in the casing. With tongue-and-groove fitted casing rings it is also imperative that the grooves be absolutely clean when reassembling a pump after it has been taken apart for any maintenance.

Old Flywheel Converted to Timing-Belt Drive



In this drive, toothed belt engages grooved pulleys

TIMING-BELT drive is an economical alternative to the replacement of a worn chain drive, reports Liebmann Breweries, Inc, of Orange, N. J. The drive in question connects a 10-hp, 1500-rpm motor to a carbon-dioxide compressor operating at 60 rpm. Flywheel on the compressor, used as a chain sprocket, was driven through a silent chain by a pinion on the motor shaft.

"We found it more economical to cut down the flywheel and buy a timing belt and a timing-belt pulley than to purchase a new chain drive," reports William Casper, the brewery's chief engineer. "A V-belt drive could not be used because the peripheral speed of the flywheel and its face width could not be increased to obtain the required horsepower. The close center lines would not permit sufficient arc of contact."

Flywheel on the compressor is approximately 24 in. in diameter. The worn teeth were machined off, and new teeth were cut to fit the grooves of the timing belt, which is 3 in. wide, ½-in.-pitch. Driving pinion was so badly worn it could not be salvaged. A new "timing" pulley was purchased. This and the timing belt were furnished by T. B. Wood's Sons Co.

Drive has been in continuous operation at Liebmann, 24 hours a day, five or six days a week, since 1956, and has not required maintenance time nor replacement parts, nor lubrication.

Auxiliary Sheave Saves V-Belt Wear

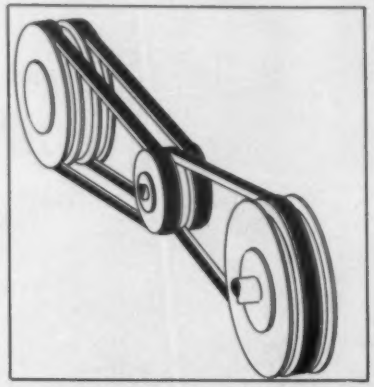
By TROY A. PRATER*

SKETCH shows how the use of any auxiliary drive sheave may be utilized to save wear and tear on V-belts.

Before the addition of the auxiliary sheave, belts twice the length of the present belts were needed and wore out approximately three times as fast. Idler sheaves were used prior to the adaption, but due to the length of belt necessary between the drive sheave and fan pulley, belt flapping and belt wear was excessive of normal operating costs.

With the adaption, as shown, we are using the same number of belts, but only half as long, and they wear three times as long. The auxiliary sheave is adjustable and can be used to adjust tightness of the belts.

*Maintenance Foreman, Sun Natural Gas Plant, Delmita, Texas



Same number of belts, wear three times as long

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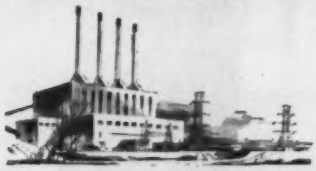

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On the other hand, for such specialized applications as combustion air preheaters they can specify high-finned Wolverine Trufin Type H/A—the integrally finned condenser tube that has an outside to inside ratio of from approximately 8:1 to 16:1.

Providing the right tube for all types of applications is, however, but one of the many benefits Tubemanship brings to Wolverine customers. Thanks to Wolverine Tubemanship you are also assured of tubing that is backed by constant research, sound engineering and held to rigid specifications by statistical quality control.

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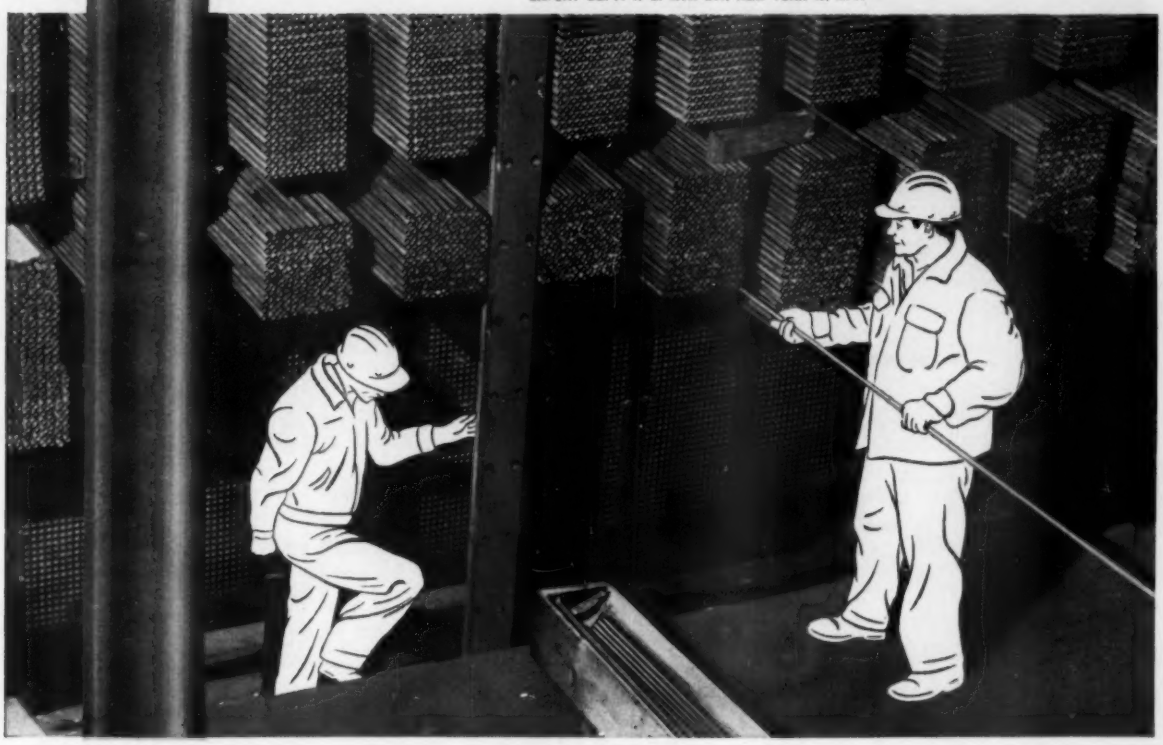

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How Can You Cure and Prevent Commutator Bar Marking?

By G. H. GUNNOE, JR.*

HERE IS a series of questions often asked the writer, and the answers he gives. They are reproduced from Bulletin GEA-6688, recently published by his company.

Q. Mr. Gunnoe, just what is bar marking?

A. Bar marking is a discoloration, or etching, of the trailing edge of the commutator bar. It results from arcing between the brush and that portion of the segment and is easily visible to the naked eye.

Q. What should we know about it?

A. First, that there are two types of bar marking. One, slot bar marking, is related to the actual winding configuration in the armature — that is, to the number of conductors per slot — and is accelerated or made worse by the electrical adjustment or load on the machine. The other type, pitch bar marking, involves several bars in groups spaced in relation to half the number of poles on the machine. If allowed to run long enough, the commutator is marked in relation to the total number of poles on the machine.

Q. Is all bar marking serious?

A. The slot marking is not serious unless the bar becomes etched. So often, the marking that develops is actually a build-up of film at this point, rather than an etched condition.

On the other hand, pitch bar marking is very serious because it will become worse as the machine is allowed to run. These marks are always lower than the other adjacent surfaces of the commutator. This means that there is a hole in the surface of the commutator, which becomes just like a hole in the pavement of a road. Every time the brush goes across it, it bounces more, causing increased sparking, and increased depth and size of the hole. As these holes get bigger and deeper, with the brushes bouncing in them with

Fig. 1. Pitch bar marking of commutator surface. Increasing brush pressure will often eliminate it

increased arcing and increased mechanical pounding, the brush life is shortened considerably. When this stage is reached, there remains only one alternative. Take the machine out of service and true the commutator.

Q. What causes bar marking?

A. Slot marking is a natural phenomenon and can be observed on any machine which has more than two conductors per armature slot. When this marking develops to the point where metal is actually being removed from the commutator bar, then it means that either the load is too great for the machine, or the machine is severely out of electrical adjustment.

The pitch-type marking is related to something cyclic which is occurring with every revolution of the machine.

Q. Can the maintenance man look for early symptoms and tell when bar marking is developing?

A. Yes. When the machine is down for maintenance it becomes very visible to the eye, especially the pitch bar marking. This bar marking may require a little closer examination because the burn spots may stop under the brush itself when the commutator comes to rest. The excessive bounce of brushes means that the marking has gone too far. Mainly, the frequent visual inspection of the machine is the best way to determine to what extent this marking is occurring, and whether it is becoming serious.

Q. What can the maintenance man do to help prevent this condition?

A. The slot bar marking cannot be entirely eliminated, but it can be controlled to the point that it is not destructive or damaging to the machine or brushes. This can be done by utilizing the proper loads on the machine; by actual electrical adjustments of the machines; by controlling the contamination of the atmosphere; and by using carbon brushes that can handle the load conditions of the machine.

Pitch bar marking is related to the contact condition of the brush on the commutator. Because of this, cyclic mechanical or electrical disturbance will increase the metal transfer at the point of disturbance when it is undergoing commutation. Therefore, it becomes necessary on a rough commutator to increase the brush pressure. In fact, many pitch bar marking conditions can be eliminated by just increasing the brush pressure. If this fails, then it will be necessary to investigate further.

Q. What else would you check in a situation like this?

A. First you must determine whether the trouble is electrical or mechanical. Actually, by feeling with your hand, you may be able to determine whether the machine is vibrating, which indicates mechanical trouble. To correct this condition may require a rotor balance or a coupling realignment. In any case, it will be necessary to reduce the source of vibration. If it is obvious that vibration is not contributing to the cause, then it will be necessary to look for shorted, or open, armature connections or a shorted field pole. On some machines extreme variation in air gaps may be the source of trouble.

Other possible trouble sources are the brush material itself and atmospheric conditions. If care is taken on all these items, chances are no serious bar marking will develop.

How Do You Handle Copper Drag?

Q. What is copper drag?

A. Copper drag, or feathering, as it is sometimes called, is small flakes of metal that appear mainly on the trailing edge of the commutator bar. Occasionally, under severe conditions, flakes can also be seen on the leading edge of the commutator bar.

Q. What causes this condition?

A. Copper drag is a rare phenomenon that occurs when the conditions of the machine aren't quite right. I have noticed over and over again that if conditions are such that we have an excessive rate of metal transfer, along with an atmospheric condition that prevents the complete oxidation of this metal as it is transferred, copper drag is very likely to develop. What happens, of course, is that the metal that is transferring is rubbed back on to the commutator as a layer of copper, copper oxide, and contaminants, and does not bond firmly to the commutator surface. As a result, the next brush that passes over this surface will shove a small flake of this material from the commutator into the commutator bar slot. Occasionally, conditions may exist where drag is noted on the leading edge of the commutator bar. This happens when metal is trans-

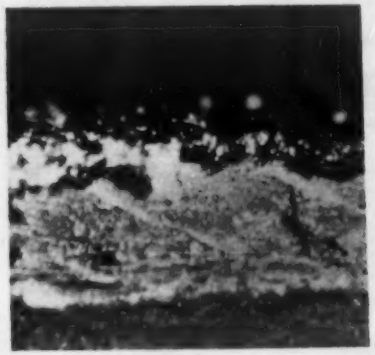

Fig. 2. Copper drag on trailing edge of commutator bar, as viewed from the side. Watch for it

* Senior Application Engineer, Carbon Products Sales, General Electric Co

fold along this line—outside edges toward you

POWER ENGINEERING HANDBOOK

REPEAT ORDERS... The Best Recommendation For DIAMOND "MULTI-PORT" GAUGES

ALABAMA POWER CO. (3 Plants) • APPALACHIA LECTRIC POWER CO. (6 Plants)
ARIZONA PUBLIC SERVICE CO. (3 Plants) • RKANSAS POWER & LIGHT CO. (3
ATLANTIC CITY ELECTRIC CO. (2 Pla BALTIMORE GAS & ELECTRIC CO. (4 Plants) •
BOSTON EDISON CO. (3 Plants) CAROLINA POWER & LIGHT CO. (5 Plants) • CALIF.
CENTRAL MAINE POWER CO. (2 P • CENTRAL OPERATING CO. (2 Plants) • CENTRAL
CINCINNATI GAS & ELECTRIC CO. (3 Plants) • CLEVELAND ELECTRIC ILLUMINATING CO. (4 Pl
COLUMBUS & SOUTHERN OHIO ELEC RIC CO. (4 Plants) • COMMONWEALTH EDISON CO. (9 Pla
CONNECTICUT LIGHT & POWER CO. (2 CONSOLIDATED EDISON CO. of N. Y. (6 P
CONSUMERS POWER CO. (3 Plants) DALLAS POWER & LIGHT CO. (3 Plants)
DUKE POWER CO. (6 Plants) • FLORIDA POWER & LIGHT CO. (5 Plants)
GEORGIA POWER CO. (3 Plants) • HOUSTON LIGHTING & POWER CO. (4 Pl
ILLINOIS POWER CO. (2 Plants) • INDIANAPOLIS POWER & LIGHT CO. (2
IOWA POWER & LIGHT CO. (2 Pla KANSAS POWER & LIGHT CO. (4 Plants)
LONG ISLAND LIGHTING CO. (3 Pl LOUISVILLE GAS & ELECTRIC CO. (2 Plant
MINNESOTA POWER & LIGHT CO. (3 MISSISSIPPI POWER & LIGHT CO. (2 Plant
MONTAUP ELECTRIC CO. (2 Plants) EW YORK STATE ELECTRIC & GAS CO. (2
NIAGARA MOHAWK POWER (4 Pl • OHIO EDISON CO. (4 Plants) •
OHIO POWER CO. (4 Plants) • OKLAHOMA GAS & ELECTRIC CO. (2 Pla
PACIFIC GAS & ELECTRIC CO. (2 Pl P DELPHIA ELECTRIC CO. (5 Plants)
POTOMAC ELECTRIC POWER CO. (5 ERVICE ELECTRIC & GAS CO. (5 Pl
PUBLIC SERVICE CO. of INDIANA (4 Plants) PUBLIC SERVICE CO. of OKLAHO
CITY PUBLIC SERVICE BOARD (SAN ANTONIO) (3 Plants) • SAN DIEGO GAS & ELECTRIC CO. (2
SO. CAROLINA ELECTRIC & GA SO. CALIF. EDISON CO. (6 Plan
SOUTHWESTERN PUBLIC SERVIC NNESSEE VALLEY AUTHORITY
TEXAS ELECTRIC SERVICE CO. (3 EXAS POWER & LIGHT CO. (3
TOLEDO EDISON CO. (2 Plants UNITED ILLUMINATING CO.
UTAH POWER & LIGHT CO. (2 Plants) • VIRGINIA ELECTRIC & POWER CO. (4 Plants)

Model MP-3000 shown is for both new and old boilers having pressures to 3000 psig. Also available in Model MP-900 for boiler pressures to 900 psig.

8266

Undoubtedly the best recommendation for the Diamond "Multi-Port" Gauge is the public utilities that use it and have placed repeat orders to equip additional boilers. A few of these are mentioned here with a note of the number of plants equipped. For the many advantages of the "Multi-Port", ask your local Diamond office or write directly to Lancaster for Bulletin 1174 (Model MP-3000) or Bulletin 2044 (Model MP-900).

Diamond

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO
Diamond Specialty Limited • Windsor, Ontario

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ferred to the face of the brush in sufficient quantity to plate a small surface. In this condition, it is quite possible the leading edge of the commutator bar may wipe this copper from the brush, welding the small flakes to the leading edge as it makes contact.

Q. How do I know when this drag condition exists?

A. The simplest way to detect copper drag is by visual inspection, by close scrutiny of the commutator bars.

Q. What symptoms can a maintenance man watch out for?

A. Early symptoms are extremely difficult to observe. In general, a close examination of the edges of the commutator bar during any shutdown of the machines will reveal whether a drag condition exists. A temporary solution to copper drag is to clean the commutator occasionally with a light brush seater stone so as to remove, or keep at a minimum, the buildup of the film. In most cases of copper drag, we have found that the film resistance on commutators is extremely low, whereas the film resistance of machines which are not developing copper drag is normal.

Q. Are there any other signs to watch for?

A. Periodic flashovers that occur without any apparent reason may be traced to copper drag. However, when this condition has been reached, it can usually be assumed the copper drag has been allowed to progress too far. To avoid this condition the maintenance man should check his machine occasionally to be sure the drag is minimum.

Q. What can I do when it occurs?

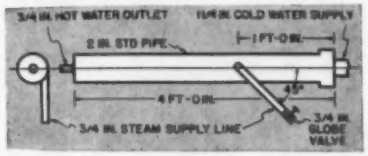
A. The simplest solution, of course, is to clean the trailing or leading edge of the bars by chamfering with the proper tools. The actual solution to copper drag is not so simple. It involves a complete study of the conditions of the machine to determine what factors appear to contribute to the excessive rate of metal transfer.

I have associated copper drag with excessive vibration, with excessive sparking, and contaminated atmospheres. If vibration and chemical contamination are not too great, then it may be possible to prevent, or reduce, the drag by the use of proper grades of brushes. Brushes of the natural graphite materials have drag tendencies in contaminated atmospheres. In some places where we have observed the use of scrubber brushes on heavily-loaded equipment, we have found drag present.

Occasionally, I have been able to cure copper drag simply by changing a carbon brush. But in most cases it may be necessary to make a thorough study of such things as atmospheric contamination and the electrical adjustment.

Making a Direct Contact Steam Water Heater

By BURL RICHARDSON*



Any steam supply should work as long as the pressure is great enough to overcome water pressure

ONE OF OUR Ljungstrom air preheaters became plugged with a sulfur deposit. The Ljungstrom service engineer advised us that we could wash the deposit off with hot water within 12 to 24 hours. However, our hot water supply would have been used up in an hour.

Not knowing that it was difficult to make a contact water heater, I came up with this spur-of-the-moment design. It worked fine. Even the service engineer was impressed with it as a solution for supplying the large quantities of hot water needed to clean air preheaters.

Our water pressure is 60 lb and steam pressure is 125 lb with about 10 deg superheat.

We were able to increase the water temperature by slowly opening the steam control valve to the point where the water at the outlet flashed to steam. There was a steady flow of hot water at all times, without hammering or spurt.

* Nebraska Public Power System

fold along this line—outside edges toward you

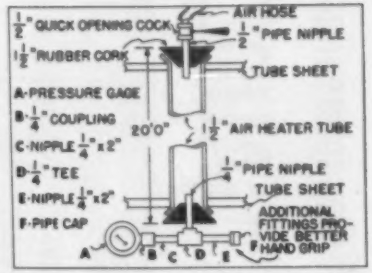
Fast Way to Test Tubular Air Heater Tubes

By C. W. MEHURON *

HERE'S AN IDEA we have used to great advantage in testing tubular air heater tubes:

Take two large rubber corks, one drilled for a ½-in. pipe nipple of the compressed air hose; the other drilled for a ¼-in. pipe nipple, to which is attached fittings for an air pressure gage.

Cork with the gage is inserted in the lower end of the tube and held securely by one man. Cork with the air hose is inserted in the top of the tube, held securely, and the compressed air is opened. Man at the lower end with the gage observes the pressure indicated on the gage. If the pressure comes up to the point equal to pressure being admitted, then the tube does not have leaks. If the tube has a leak, then the pressure does not build up.



Two-man system takes less than 30 sec to test tube

It takes less than 30 sec to check each tube, and by using a quick opening cock the two men can go from one tube to another as fast as it takes to open the air valve, check the pressure, signal back and forth, and shut off the air.

Saving Time on Cleaning Tubular Air Heaters

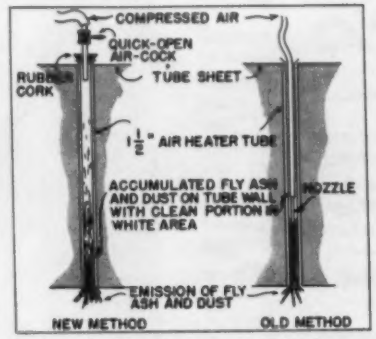
By C. W. MEHURON*

Here's another method we have recently put to use, which has cut the time spent in cleaning tubular air heaters on our three 75,000 lb per hr boilers. First, how we used to do it:

Compressed air hose with a drilled nozzle tip was fed through the entire length of an air heater tube. The hose was marked so that the worker would know when the nozzle tip had reached the other end of the tube and then the hose would be quickly withdrawn and inserted into the next tube.

The new method (see sketch) eliminates the time-consuming process of feeding the hose down through the entire length of the tube. A rubber cork is fitted over the pipe nipple in the end of the air hose, hose is placed in the top end of the tube, held firmly in place and the compressed air cock opened. The rubber cork prevents blowback of the air and dust, and the tube then acts as a continuation of the air hose. The tube is blown clear of the fly ash and dust.

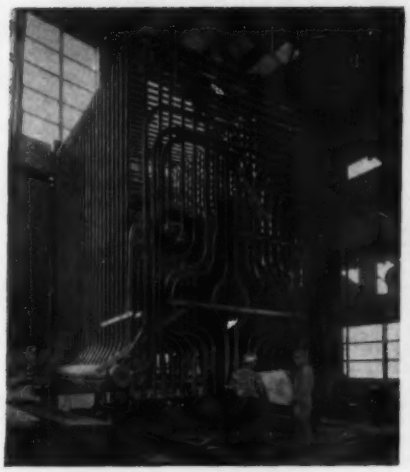
* Chief Power Plant Supervisor, American Maize-Products Co, Roby, Ind.

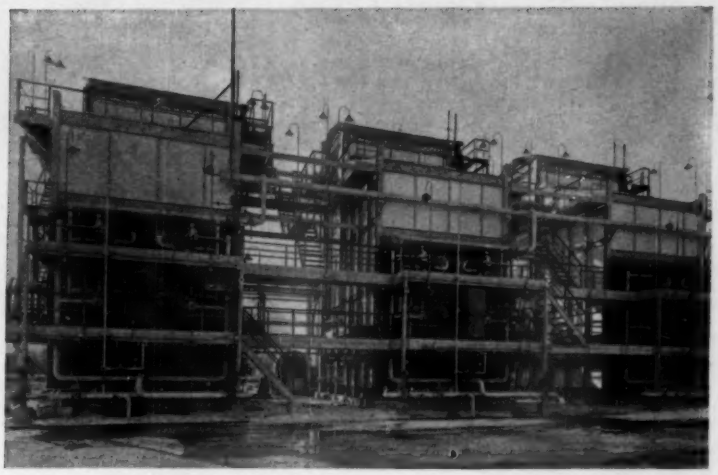


Six hours for the old, not over two for the new

The old method required up to six hours for blowing out the air heater tubes for each boiler. (This blowing is of course done when the boiler is shut down and cooled.)

With the new method we can clean the same number of tubes in not more than two hours.





AT LEFT: Installing a 60,000 lbs/hr unit in a brewery

ABOVE: A battery of 125,000 lbs/hr units in a chemical plant

CUSTOM *Steam* GENERATORS by Vogt

Vogt engineering advances can save you money if you have a steam generating problem. Custom-built installations shown, are engineered to assure efficient, dependable steam generation for power, process and heating. Our engineering staff is available to give effective help in the solution of steam generating problems peculiar to a wide variety of operating conditions. Address **Dept.24A-BPE.**

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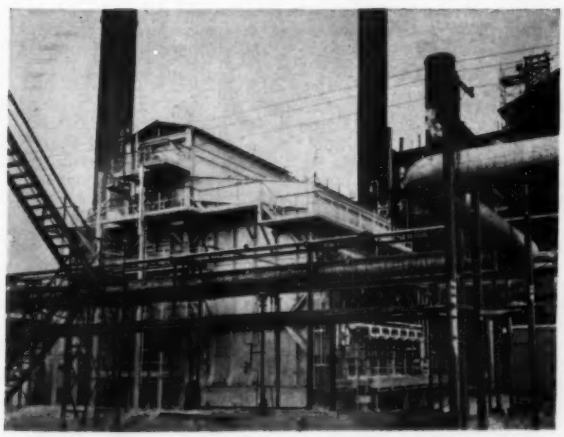
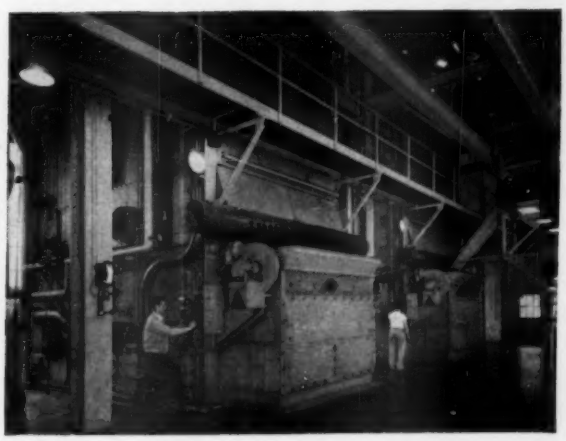


This 400,000 lbs/hr unit is installed in a leading petroleum refinery



Three 40,000 lbs/hr units serve a medical center

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CONSTRUCTION NEWS

Birmingham, Ala. — Alabama Power Company, Alabama Power Company Building, has announced that company has under way the construction of hydro and steam electric generating projects representing a total investment of $335,000,000, to be made in these and related projects in the period 1958 through 1968. Among the projects are the complete development of the power potential of the Coosa River now partially developed, continuation of a large hydro-electric dam and power plant on the Warrior River, installation of generating facilities in navigation dams on that river, additions to existing steam-generating plants and 50% participation in the construction of the $150,000,000 Southern Electric Generating Co, steam plant.

Anchorage, Alaska — Chugach Electric Association, has announced that site investigations have been completed for a $20,000,000, atomic power reactor here on which work is expected to start in 1961. The Atomic Energy Commission will finance the installation which will produce about 10,000 kw when completed in 1963. The reactor housed in heavy concrete building with a steel shell cover will be of the sodium deuterium type and will operate on a 200-degree temperature rise in sodium which moves through heat exchangers to provide steam for use in power generation. A larger plant is planned, if the first unit works out according to plan. The Nuclear Development Corp, White Plains, N. Y., will be in charge of construction of the unit.

Little Rock, Ark. — Arkansas Power & Light Co, Fourth and Louisiana Streets, has plans under way on construction of extensive electric transmission lines serving company's area. Plans call for the construction of a 90-mile, 230,000-volt electric transmission line from company's power plant at Helena, Ark., to Pine Bluff; a 3.8-mile, 115,000-volt electric line; a 6.5-mile, 115,000-volt electric transmission line in the vicinity of Hope and Hempstead Counties. Work will go forward under supervision of Ebasco Services, Inc, New York, N. Y., at a cost of $4,182,000; $266,000; and $285,000 in their respective order.

New Haven, Conn. — United Illuminating Company, 80 Temple Street, has announced plans for the construction of new generating unit at company's Bridgeport Harbor Station. Company expects to break ground soon for a 165,000 kw generating unit, the second installation at this plant. Present plans call for the unit to go on line in the fall of 1961, at a reported cost in excess of $20,000,000. Financing has not as yet been formulated but company plans to initiate the first phase late this year. Capital expenditures of the company for 1959 will run about $10,000,000, including costs incurred in connection with the start of the new unit and for normal additions and improvements to plant and property.

Tampa, Fla. — Tampa Electric Co, Cass & Tampa Streets, has announced that construction has started on a third steam-electric generating unit at company's Gannon Station having a capacity of 175,000 kw. Cost of the new unit scheduled for completion in 1960 was not announced but company stated that future expansion will require expenditures of approximately $25,000,000 for the next few years. Construction expenditure will be down moderately this year to about $21,487,000 from a total expenditure in 1958 of $23,000,000.

Savannah, Ga. — Savannah Electric & Power Co, 27 W. Bay St, has announced that plans are under way for major expansion of company's steam-electric generating capacity. Rapid growth within company's territory has necessitated a better than five fold increase in generating capability of the company over the past two years. Company has announced plans for the addition of No 2 unit at local plant with a capacity of 55,000 kw to be completed sometime in 1961. Company has also announced proposed plans for a third unit if growth trend continues projected for 1964 or 1965. New unit now under construction will represent an expenditure of approximately $10,000,000.

Decatur, Ill. — Illinois Power Company, 134 E. Main St, has authorized plans for the expenditure of $36,000,000 for capital improvements in 1959 and involving a figure of $200,000,000 over the next five year period. $26,800,000 of the total budget will go toward increased generating capacity and for improvements and additions to company system. Largest item in the electric budget is the construction of a new generating unit with an initial capacity of 225,000 kw to be installed at company's Hennepin Power Station, bringing the utility's total generating capacity to 1,045,000 kw.

Newark, N. J. — Public Service Electric & Gas Co, 80 Park Place, has announced plans for the expenditure of approximately $160,000,000 on new construction during 1959. This will mark the fourth consecutive year in which the company's construction expenditures have exceeded $100,000,000. Capital outlays for 1958 totaled about $125,000,000. The company will add 1,220,000 kilowatts of generating capacity to its lines over the next three years to bring company's total capacity to approximately 3,692,500 kilowatts, an increase of 45% over the capacity at the beginning of 1958. Company has under construction two generating stations, one at Ridgefield, N. J. and the second at Duck Island, Trenton, N. J.

Eugene, Ore. — Eugene Water and Electric Board, this city, has announced that the Power Commission has granted a fifty-year license for its proposed $19,318,000 Carmen-Smith hydro-electric project on the McKenzie and Smith Rivers in Lane and Linn Counties. Project to include three dams, namely, Carmen, Smith River and Trail Bridge would have an installed capacity of 53,500 kw. Simultaneously, the Power Commission accepted the board's voluntary surrender of a license for a proposed Beaver Marsh project, since the board stated that the Carmen-Smith development would be more beneficial.

Philadelphia, Pa. — Philadelphia Electric Co, 1000 Chestnut Street, has authorized an estimated capital expenditure of about $120,000,000 for 1959. Part of this amount will go toward completion of company's new Eddystone Station No 1 unit of 325,000 kw capacity which is scheduled for operation late this year and toward the beginning of a No 2 unit of like capacity which will be added in 1960. Company has recently placed in operation a 185,000 kw turbine generator at its Schuylkill Station, doubling the electric generating capacity of that plant.

Aiken, S. C. — The Atomic Energy Commission, 1901 Constitution Ave, N. W., has announced that construction is under way on the Heavy Water Components Test Reactor at the Savannah River Plant of the U. S. Atomic Energy Commission. Of the $8,000,000 allotted for the project, approximately $6,400,000, will go toward construction purposes and purchase of equipment and materials. The experimental reactor will assist the DuPont Company in answering numerous questions in a developmental study undertaken for the AEC by that company to determine the feasibility and economics of heavy-water moderated reactors for electric power generation.

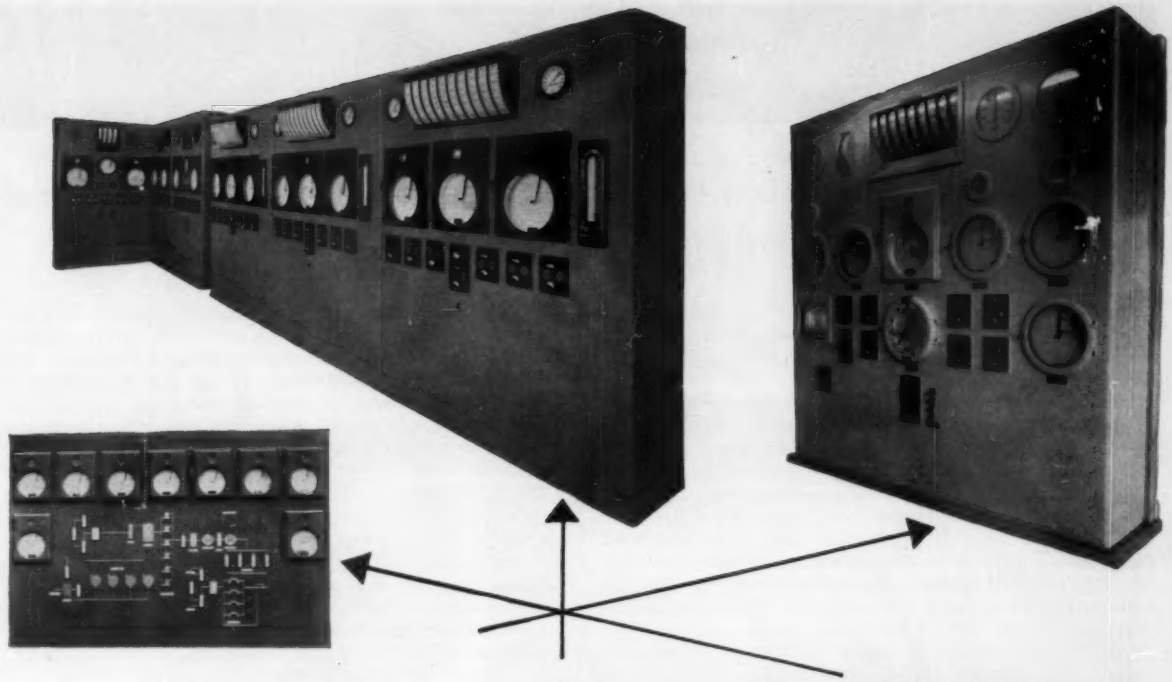
Amarillo, Texas — Southwestern Public Service Co, 418 Polk St, has authorized a major construction and expansion program of company's generating and transmitting facilities with the following proposed expenditures over a three year period, — $14,009,000 in 1959; $18,900,000 in 1960 and $17,300,000 in 1961. These expenditures include the construction of a new steam-electric generating unit now under way with an initial capacity of 112,500 kw. New plant is expected to go on line by mid-1961. Company expenditure on new construction for 1958 totalled about $11,714,000.

Milwaukee, Wis. — Department of Municipal Power & Light, City Hall, has plans under consideration for the construction of a steam-electric generating plant which will use heat exhaust from local incinerator plant operated by the city. Plans for the facility are under the supervision of E. A. Schmidt, city engineer, and the proposed project, when completed, will cost an estimated $2,300,000.

Correction Note: — In the October 1958 issue, an item on this page said that Delaware Power and Light Co has announced plans for the expansion of the company's Indian River Power Station at Millsboro, Delaware. The company states that it has no plans at present for any further expansion of the station beyond the first and second units, as stated in an article just ahead of the Construction News page on page 95 of the same issue. The item of $25,000,000 for the cost of the addition was given in error. This was the approximate cost for the first two units.

On page 90 of the November 1958 issue, an item stated that New York State Electric & Gas Co has plans for a new power generating station at Somerset, New York. The public relations department of that company states that it has released no information to this effect and does not know anything about it. However, the source of this item states he has definite information that the company has acquired a site there, but had no immediate plans for a power generating station. That acquisition undoubtedly gave rise to the report.

Our apologies for any inconvenience caused by our original items, which came from sources that we had no reason to question at the time.



Base Any Of These

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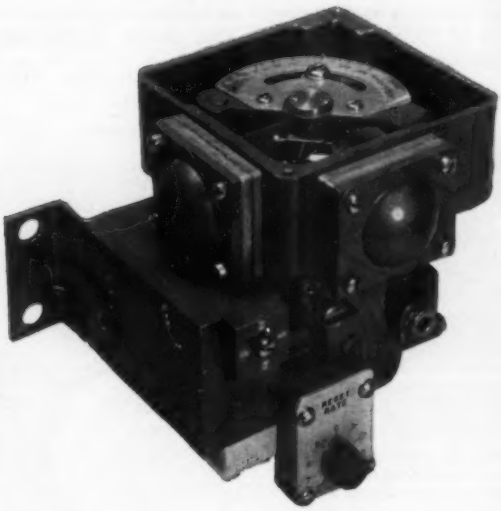

For accurate, efficient, dependable control systems— REPUBLIC'S NEW TYPE "VC" PNEUMATIC CONTROLLER

Here is an all purpose null-balance-vector controller for use with any pneumatic transmitter. Its proportional band ranges from 2% to 500% *without changing parts*, for quick adaptation to changes in process requirements. Especially important in high-precision control, Republic's Type VC has exceptional sensitivity and a narrow dead band (less than 0.05%). Its high capacity non-bleed pneumatic amplifier consumes little air, keeps output ample. A selector block permits reverse or direct action; local or remote pneumatic set point optional.

Companion instruments—using an identical null-balance-vector "heart"—include differential pressure, temperature and pressure transmitters . . . ratio, totalizing, multiplying, squaring and square - root - extracting relays. Many parts are interchangeable among the instruments in this "family". Besides reducing spare parts inventory, the similarity of components simplifies the task of training personnel.

Let a Republic engineer show you how these instruments can help to achieve accurate, efficient, dependable control systems. Republic Sales Offices are located in principal cities throughout the U.S.A. and Canada.

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Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

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See why ALCOA ALUMINUM makes a good design habit

Requirement: Low-cost, corrosion-resistant heat exchanger material
Key to Good Design: Specify Alcoa Aluminum Tube and Sheet

If corrosion resistance, long life, product purity and economy are considerations in your heat exchanger application, specify aluminum! ALCOA® Aluminum has been solving such problems for over 40 years.

In the petroleum industry, ALCOA Aluminum Tubes serve in main column overhead condensers where their freedom from fouling and excellent heat transfer properties have made them a natural selection. Heat exchangers made of ALCOA Aluminum Tube and Plate are used in the production of ammonia, nitric acid, vegetable oils, naval stores, naphthalene, hydrogen peroxide, oxygen and urea. These and other processes call for heat exchangers with combinations of high strength, excellent sub-zero physical qualities, high thermal conductivity, or nontoxic and noncatalytic properties. ALCOA Aluminum alloys meet all these requirements.

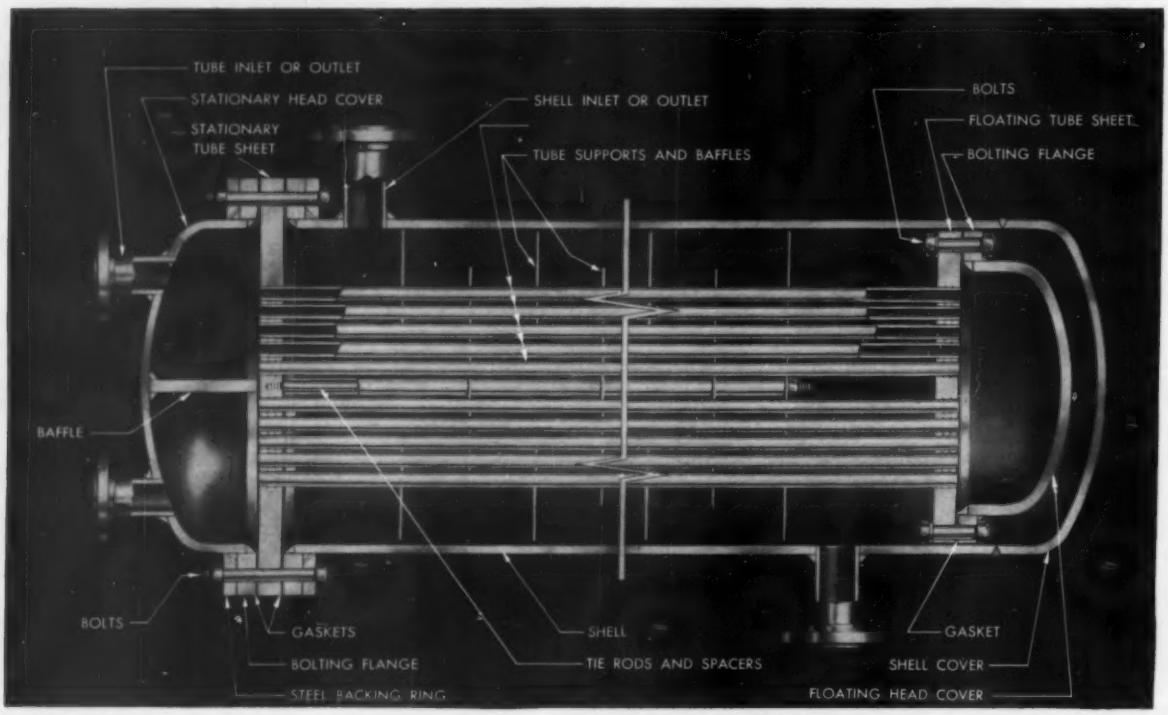
As for cost, ALCOA Aluminum Tube is the most inexpensive. In the common sizes it costs one-third less than mild steel, one-half as much as admiralty, and one-fifth that of stainless.

ALCOA Aluminum alloys are ideally suited to a wide range of maintenance methods. For relatively soft or loose scale, water jets and brushes are usually satisfactory. Wet sandblasting as well as chemical cleaners may be used effectively.

ALCOA engineers have worked closely with all segments of the process industries for over 40 years, and can help you specify the aluminum alloy best suited to your heat exchanger and other process applications. ALCOA's unparalleled experience in this field is available to you for the asking. Write to the address below, stating your requirements as specifically as possible. ALCOA's development engineers will welcome the opportunity to work with you on your problems.

You can also take advantage of the wide selection of free ALCOA literature on aluminum for heat exchangers and other process applications. Simply check the booklets you want on the coupon and mail to the address below. ALCOA will forward your material promptly and without obligation.

ALCOA is conducting a series of engineering conferences on process industries applications of aluminum during 1959 in a number of major cities. Contact your nearest ALCOA sales office for full particulars and dates.

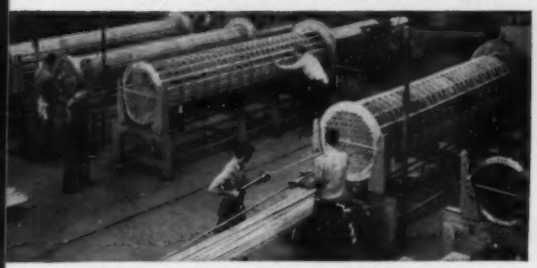


For certain processes where corrosive or sensitive materials are involved, it is often advisable to use aluminum for entire heat exchanger systems to avoid system corrosion and contamination of the product. A typical all-aluminum heat exchanger is shown here. Alloy recommendations are given in the table opposite.

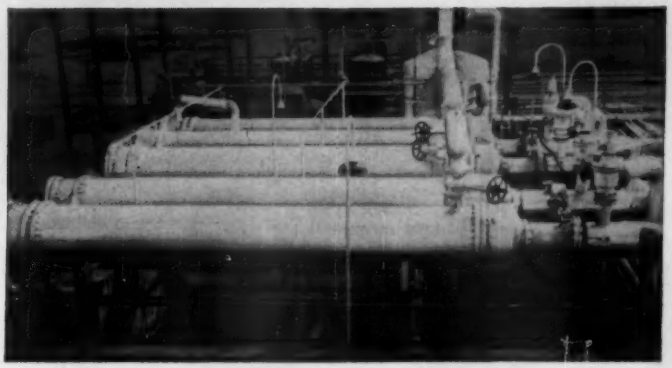
Alcoa Aluminum Tubing protects color in the world's largest rotary steam-tube drier. The drier measures 10 ft in diameter by 100 ft long.

A Midwest utility saved 50 per cent on tubing costs by using Alcoa Aluminum instead of admiralty for tubing in this surface condenser. Successful operation of this unit has led to the installation of similar units by other utilities. This use demonstrates aluminum's economy and superior resistance to ammonia, carbon dioxide and hydrogen sulfide.

A battery of all-aluminum heat exchangers in a polyethylene plant. Selected for initial low cost, these aluminum exchangers provide freedom from product contamination as well as desirable low temperature properties.



Construction of a heat exchanger utilizing Alcoa Aluminum Tube. Superior working properties plus the cold-drawing method by which Alcoa seamless heat exchanger tubes are produced results in close dimensional tolerances and smooth inside and outside surfaces.

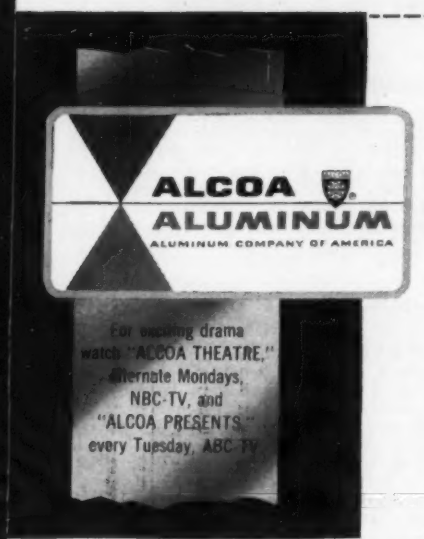


This all-aluminum dephlegmator in a large coke plant is used for the regeneration of ammonia liquor in a hydrogen sulfide scrubbing operation. Aluminum tubes lasted five times longer than steel tubes in a similar use.

Alloy Recommendations for Aluminum Heat Exchanger Construction

	Alcoa Designation	ASTM Specification*	Alloy
Tubes	3003-H14	B234	M1A
	Alclad (inside) 3003-H14	B234	clad M1A
	Alclad (outside) 3003-H14		clad M1A
	Alclad (both sides) 3003-H14		clad M1A
	6061-T6	B234	GS11A
	6062-T6	B234	GS11C
Tube Sheets	3004-H112	B178	MG11A
	Alclad 3004-H112	B178	clad MG11A
	6061-T6	B178	GS11A
	Alclad 6061-T6	B178	clad GS11A
Baffles	3003-H14	B178	M1A
	Alclad 3003-H14	B178	clad M1A
Tie Rods	6061-T6	B273	GS11A
Shells & Headers	3003-H112	B178	M1A
	Alclad 3003-H112	B178	clad M1A
	3004-H112	B178	MG11A
	5052-H112	B178	GR20A
	5154-H112	B178	GR40A
Fittings	3003-F	B274	M1A as applicable
	6061-T6	B274	GS11A as applicable
Flanges	6061-T6	B247	GS11A as applicable

*Only the basic number is shown since Alcoa products are manufactured to the latest issue of the specification. The complete number would indicate the year of issue.



Aluminum Company of America
876-C Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature covering Alcoa Aluminum in heat exchanger and other applications in the process industries.

- ☐ 10186 Alcoa Aluminum Heat Exchanger Tubes
- ☐ 20437 Aluminum Alloy Heat Exchangers in the Process Industries
- ☐ 10460 Process Industries Applications of Alcoa Aluminum
- ☐ 20849 Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres
- ☐ 20272 Aluminum Alloys for Handling High Purity Water
- ☐ 20268 Resistance of Aluminum Alloys to Fresh Waters
- ☐ 20935 Designing to Prevent Corrosion

Name_____

Company_____

Title_____

Address_____

City_____

State_____

For more data circle 540 on Post Card

EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 113–114 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—DATA LOGGING SYSTEM for new, existing equipment

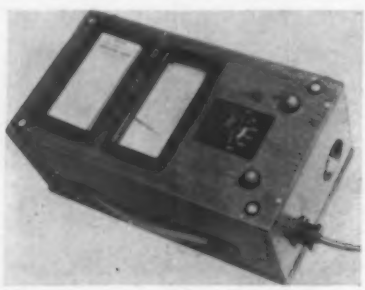
Called APRIL (automatically programmed remote indication logging), this system is designed for applications where accurate centralized data transmitting and logging systems are required. APRIL can be incorporated as part of a new supervisory system or added to existing installations of company's equipment. It can be used on its own channel, or on the supervisory channel when required. The system can be broadly applied to the pipeline and petroleum industries, electric utilities, commercial buildings, industrial power distribution systems. Claimed more accurate than previously available equipment, APRIL converts analog-type quantities to a binary code form and transmits the information from a remote location, by means similar to that used in manufacturer's standard supervisory equipment. When received at a master station, the code is converted to decimal form for visual display or logging using an electric typewriter. General Electric Co.

2—WALK-IN ENCLOSURES protect men, equipment

Shelter-Clad Enclosures are designed to provide protection against the elements for operating personnel and 2000-to-5000-v motor control in outdoor installations. The enclosures consists of two facing rows of company's Type H motor controls bridged by a metal roof. Backs of the control cabinets form the out side walls of the unit. A 5-ft wide aisle extends the length of the enclosure which has door at each end. The basic unit can consist of any number of facing cabinets and any number of pairs of cabinets can be added or removed. Cabinets can also be had without instrumentation and arranged for office or storage use. They can be provided with lights and bus ducting can be from overhead, below or through the side. Allis-Chalmers Mfg. Co.

3—INSULATION RESISTANCE TESTER for step voltage testing

This rectifier-operated Megger Insulation Tester is intended for making step voltage tests on insulation of electrical equipment in the higher voltage ranges . . . rotating electrical machinery rated 230, 440, 550, 2500 v a-c and d-c, wiring installations and cable with smaller conductor sizes and insulation rated 600 v, dry type transformers, others. The instrument features a single range of 0–10,000 megohms for six voltages. Manufacturer points out that recent electrical maintenance practices indicate value of testing insulation with d-c voltages at levels somewhat higher than peak value of the rated a-c voltage of equipment being tested. The technique involves application of two or more d-c voltages and critical observation of any reduction of insulation resistance at the higher voltage. Excellent voltage regulation characteristics and high sensitivity are claimed for this instrument. The six output voltages are 500, 750, 1000, 1500, 2000, and 2500 v. Details are in Bulletin 21-20a. James G. Biddle Co.



4—ANGLE HEAD DRILLS work in tight quarters

Two angle head pneumatic drills are introduced to speed up production drilling in corners, crevices and other hard-to-reach locations. Both are lightweight, yet have powerful pneumatic motor. Model 400-AA features an all-angle head, adjustable through 360 deg. The tool has a ¼-in. capacity, is 8¾ in. long and weighs 2¾ lb. Model 400-RA has fixed 90-deg angle head. This one-hand operated ¼-in. capacity drill is 10½ in. long and weighs 3⅛ lb. Both models have handy lever or lock button throttle control, three-jawed chuck. They are furnished in 600- to 5000-rpm models. Airetool Mfg. Co.

5—INSULATING VARNISH wards off fungus damage

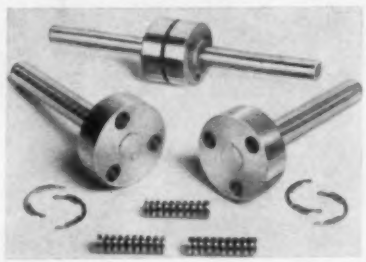
No. 642-AF Fungicidal Insulating Varnish is described as a clear, fast air-drying product for protecting electrical and electronic equipment. Applied to the surface of instruments, transformers, printed circuits, ceramic resistors, and insulators subject to fungus attack in hot, humid climates, it serves to prevent growth of fungus which can cause surface leakage and potential arc-over paths. Because it is water white in color, and does not "after-yellow" this varnish is suitable for application over stamped or painted numbers, manufacturer notes. Schenectady Varnish Co., Inc.

6—FANS for mechanical draft, heavy duty use

Incorporating an advanced airfoil, backward curved blade design, the Type F Dynafoil Fan is reported particularly adaptable to mechanical draft and heavy-duty applications. The wheel is built with 12 aerodynamically shaped blades which, in combination with the streamlined contour of the inlet, permits a continuously smooth flow of air through the fan. Turbulence is consequently minimized, it is pointed out, making the fan efficient and quiet. The fan comes in 13 sizes for mechanical draft and in Class II, III and IV for heavy duty industrial applications. The fans are also suited for air conditioning systems, tunnel ventilation. Catalog 905 gives details. Clarage Fan Co.

7—FREE-ALIGNING COUPLING features design simplicity

No nuts or bolts are used in the construction of this free-aligning coupling, described as so simple in design that machinery can be connected with a screwdriver. Halves of the coupling are joined and transmit thrust through helical, wire springs which are held in place by snap or split rings. The coupling operates in either direction of rotation and can be installed vertically without any parts change. The coupling is shock absorbing, company says, and permits maximum misalignment because it transmits torque without end thrust, even under load. Coupling has load factor of 7:1, is available in any size, but is standardized in three series — light, medium and heavy, with shaft sizes ranging from 2- through 12-in. diam. Automatic Mfg. Co.

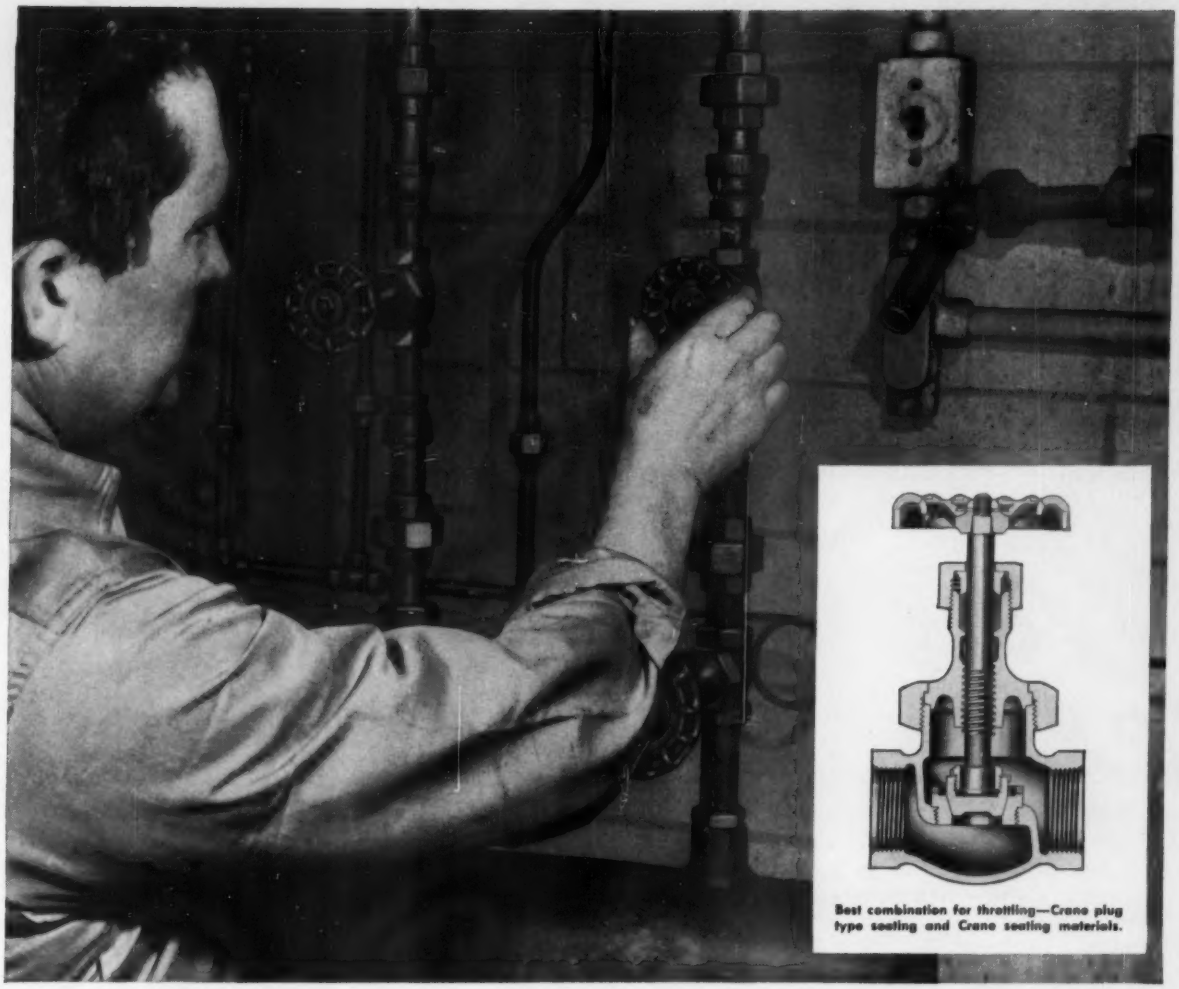


8—NEUTRALIZING AMINE for steam condensate systems

Neutrameen is a water soluble neutralizing amine prepared so as to have no flash point, and is for use in the control of carbon dioxide corrosion in steam condensate systems. Neutrameen is blended as a liquid, and supplied in steel drums and pails. Betz Laboratories, Inc.

9—HAND SINKER permits dry, dustless drilling

The LHV45 is announced as a dry, dustless drill, approved by the Bureau of Mines. It is designed to improve working conditions for operators and eliminate dusty conditions during plant remodeling — allowing drilling near machinery where dust damage could be costly. Steel sticking is practically eliminated, according to manufacturer, because cuttings are collected as drilling progresses. Cuttings are drawn into five-



Best combination for throttling—Crane plug type seating and Crane seating materials.

Surprising savings for this power plant with Crane bronze throttling valves

At least once a year, this power plant of a leading machine tool builder was replacing the valves in the ½-inch continuous blowdown lines on its 60,000-pound boiler.

They were high-priced valves, but they couldn't take the continual throttling service. The seats cut out rapidly . . . blowdown regulation was lost . . . valve costs kept rising.

Thirty-one months ago this plant replaced the short-lived valves with Crane No. 212P, 200-pound bronze globe valves with plug type disc. Most of the time these Crane valves have been operating at less than half-open.

Yet, at every inspection to date, they've been found O.K.—no seat damage . . . no loss of regulation . . . no maintenance needed. Another proof of the economy of Crane quality!

To cut your valve and piping maintenance costs—on steam or any fluid—call in your local Crane Man. He has more to offer in money-saving piping materials.

COST-SAVING IDEAS FOR YOU in this free 36-page book of "Valve Performance Facts." Get your copy from your Crane Man or write to address below.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

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hole CRD or Vac-Nu-Matic bits, through hollow drill steel, into the drill chuck, and out the side of the chuck housing. The cuttings do not go through the drill, it is noted, nor do they come into contact with its working parts.

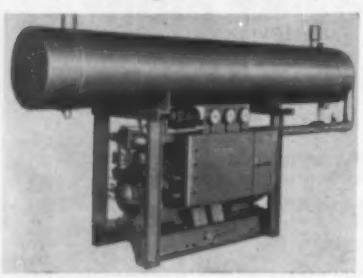
Designed to operate with the LX-1 automatic dump dust collector tank, the drill is of medium weight (56 lb) and has a 1-in. hex by 4¼-in. chuck. Drill and collector tank operate at 80 to 90 psi. The tank weighs only 45 lb, and its door can be operated remotely from the drill throttle valve, allowing drilling of many holes without emptying the tank. LeRoi Div., Westinghouse Air Brake Co.

10—VOLT-OHMMILLIAMMETER has many test applications

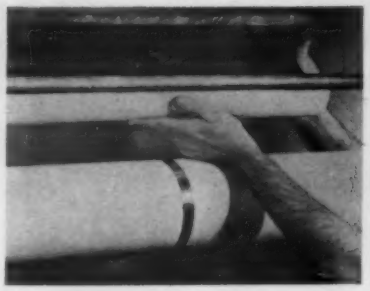
Increased range and ruggedness in a smaller size are features announced for the Weston Mark II Analyzer, Model 980. This sensitive and sturdy volt-ohm-milliammeter is engineered for a wide range of test measurement applications in the electrical and electronic fields. It has a d-c sensitivity of 20,000 ohms/volt, and an a-c sensitivity of 1000 ohms/volt. It is claimed to offer accuracy within 2 per cent full scale d-c and 3 per cent a-c. A single dial control simplifies range and function-switching. Company's Cormag mechanism protects the instrument against magnetic disturbances, and electrostatic shielding is provided to assure accurate measurements at high d-c voltage. The analyzer sells for around $45.00. Optional extras include high voltage probes which can measure voltage up to 20 kv at 50 microamperes or less, and a tilt stand and cover. Weston Instruments Div., Daystrom, Inc.

11—WATER CHILLERS offer design improvements

Packaged water chillers in the redesigned Type CD line come in nine sizes from 20 to 125 hp for air conditioning or industrial cooling applications. The new design retains copper tubing with a star shaped aluminum insert within the evaporator. According to manufacturer, this



tubing configuration has more than double the heat-transfer surface of plain tubing and adds 25 per cent more cooling capacity per cubic foot of chiller size. Among new features is a capacity control actuated by crankcase suction pressure. The compressor is directly driven by an electric motor through a flexible coupling. This high-speed compressor lets the unit be more compact and reduces weight. Trouble indicator lights are an added feature. Should an abnormal condition cause the unit to cut off on any of the four safety controls, the appropriate light will identify the source of the trouble. Wiring is color coded throughout. American Blower Div., American Standard.



12—PIPE INSULATION of rigid cellular glass

Foamglas Stay-Dry Pipe Covering is a low-cost rigid cellular glass insulation for piping applications from 35 to 350 F. According to manufacturer, production economies permit offering this vapor-proof, incombustible Foamglas covering for about the same cost per linear foot as other commercial pipe insulations. The material comes in 24-in. lengths, factory-wrapped with a dual purpose kraft and aluminum foil laminate. The white laminate serves as a tough protective jacket and has an attractive finished appearance, or it can be painted with a water-base paint.

Ease and speed of installation are stressed. Due to high compressive strength of Foamglas, the covering can be installed before or after hanging the pipe. Hangers can go around an insulated pipe section without compressing the insulation, it is stated, and it is not necessary to prime the pipe before applying the covering. The section opens lengthwise and fits around the pipe. The overlapping longitudinal seam of kraft-foil laminate is sealed with lapping cement and banded. End joints are sealed with vapor barrier strips furnished. The covering comes in nominal thicknesses of 1 and 1½ in. for ½- to 6-in. steel pipe or copper tubing. Pittsburgh Corning Corp.

13—FLEXIBLE CONDUIT comes in three types

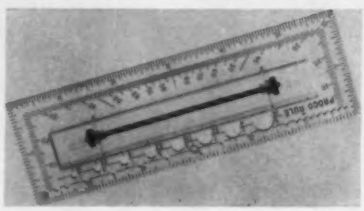
Liquatite Type L. A., with continuous copper wire in the core, carries Underwriters' approval as required in various code specified installations, says manufacturer, and Liquatite Types H. T. and L. T. both meet J. I. C. specifications. The former is designed to withstand temperatures to 220 F; the latter is for general duty applications. All types are made from heavy, spirally-wound, square-locked galvanized metal, either cord or wire packed for consistent bending diameters. The extruded polyvinyl jacket protects against oil, chemicals, water, corrosive fumes and other conditions. Liquatite comes in payout cartons or reels, in black or gray. Electri-Flex Co.

14—GATE VALVE is easily dismantled and reassembled

Two valves added to company's line of bronze industrial gate valves feature union bonnets which permit frequent dismantling and reassembly for inspection and service. The union design provides added strength at the bonnet joint, company says, in addition to making a leaktight joint. When the union ring is pulled down, body and bonnet mating surfaces come together for a tight seal that cannot become loosened during ordinary operation, it is claimed. The rising stem valves are made in sizes from ¼ through 3 in. in pressure ratings of 125 WSP — 200 WOG and 150 WSP — 300 WOG for steam, water, air, gas, gasoline or oil. With discs in full position, valves can be repacked under pressure, it is noted. Ohio Brass Co.

15—ENGINE GENERATOR for portable electric power

The Winco Mite weighs only 89 lb and is designed to deliver 1500 w of portable electric power for a-c and a-c/d-c portable tools. The engine generator is equipped with an automatic idling control which brings the engine to full speed when power is called for, otherwise the engine runs at a slow idling speed to save fuel and reduce engine wear. It is powered by a recoil starting four-cycle engine. Under $350. Wincharger Corp.



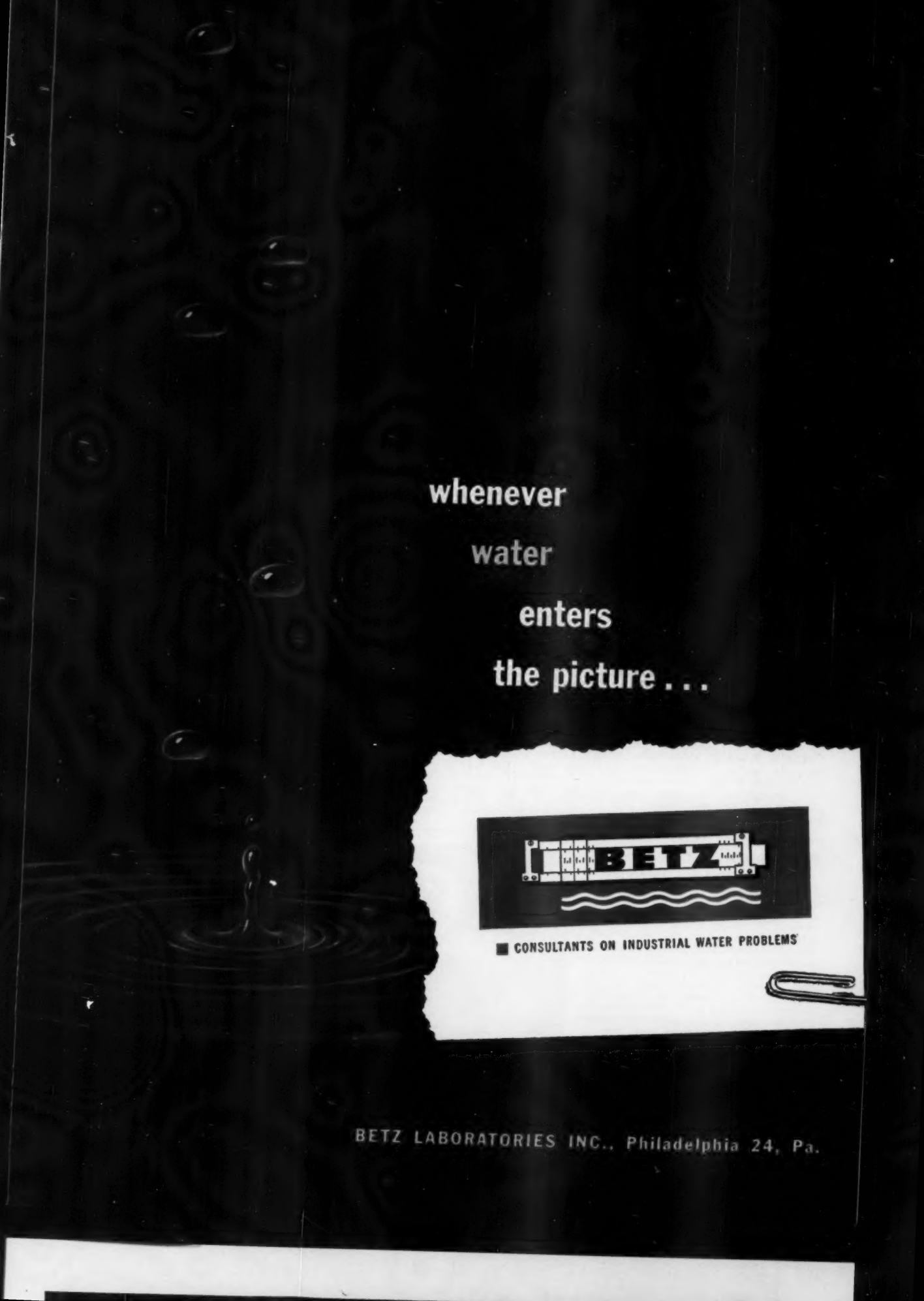
16—SKETCHING TOOL with "built-in" drafting aids

The Proco Rule, a rolling ruler, takes the place of all drafting tools for small drawings, says manufacturer, yet it can be carried in the pocket ready for use on any flat surface. It requires no adjustments and there's nothing to put together. It is explained that the roller construction carries the rule in a straight line, keeping the edge parallel. A scale on each end permits spacing of parallel lines, company notes, and there is no side play which permits lines perpendicular to the edge to be drawn. It contains a protractor and this, combined with the rolling action, is designed to enable drawing angles faster. It also contains a template for small circles and provides a method for making larger circles up to 6-in. radius. Its overall size is 6-by-2-by-½ in. Fullerton Engineering Sales Co.

17—MOISTURE MONITORS with high-pressure capabilities

Moisture monitors in the Type 26–350 series are claimed capable of rapid and accurate measurement of trace quantities of moisture in gases, gaseous mixtures and vapors at sample pressures to 10,000 psig. Applications for the instruments include testing moisture in pneumatic control systems and bottled cylinder gases; determining water content in chemical process streams; testing of natural gas; monitoring of hydrogen feed in ammonia plants; measuring of dryer performance on compressors. They will accommodate high-pressure gases, such as air, hydrogen, nitrogen, oxygen, natural gas, hydrocarbon vapors and helium. One instrument is rated for use at sample pressures to 3500 psig, another those to 6000, and a modified version for those to 10,000 psig.

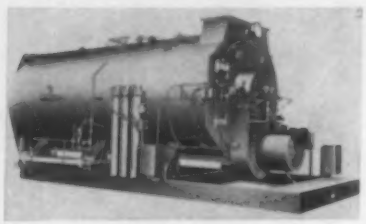
Based on an electrolytic process the


whenever
water
enters
the picture . . .
BETZ
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS
BETZ LABORATORIES INC., Philadelphia 24, Pa.

monitors cover a dynamic range of 1 to 1000 ppm, and are reported virtually independent of variations in sample composition, since the electrolysis is specific to water. Each instrument has a built-in high-pressure regulator, high- and low-pressure sample bypass, adjustable flow-control system, and plug-in electrolytic cell. Bulletin 1855 gives further information on the instruments. Consolidated Electro-dynamics Corp.

18—750-HP PACKAGE BOILER offers compactness, efficiency

Announced as the highest capacity fire-tube boiler package boiler, this unit is designed to deliver 26,000 lb of steam



per hour at over 80 per cent efficiency. Because of the Cyclonic combustion principle incorporated in its design, this boiler is claimed no larger than most 500 hp package generators; its overall dimensions are 28-by-9½-by-10¾ ft. While designed for heavy oil or gas, the boiler can use LP-gas, light oil. Cyclotherm Div., National-U. S. Radiator Corp.

19—ALUMINUM PIPE utilizes variable wall principle

Unistrength Pipe is described as a low-cost, seamless, one-piece pipe combining thin walls with a standard wall thickness at pipe ends. The resulting weight reduction is claimed to have lowered costs, narrowing considerably the price gap between aluminum and steel. At the same time, manufacturer says, variable wall principle strengthens joints, usually the weakest link in a piping system, by concentrating metal at pipe ends. The pipe is adaptable to all joining methods, and is available in 40-ft lengths with 40 wall thicknesses at the ends, permitting the use of standard aluminum fittings and flanges. Aluminum Co. of America.

21—BATTERY CHARGERS offer improved voltage control

These silicon-rectifier battery chargers are announced as providing the most accurate voltage control available for stand-by batteries. Using an electrical rectifying system for converting alternating current directly to the direct current required for charging, the units are controlled by a magnetic amplifier with a sensing control circuit which serves to automatically maintain proper charging voltage at battery terminals. The chargers are for use with stationary batteries in electric utility service, in emergency power and lighting and in other float-charge battery applications requiring accurate charge control.

These silicone rectifying units maintain high electrical efficiency even under light electrical loads, says manufacturer, and voltage regulation within ±1 per cent extends over complete range despite input variations up of ± 10 per cent. The chargers come in 27 basic models for use with batteries having 11 to 62 cells. Single- and three-phase units are available, having an output range of 1 to 400 amp. All models have voltmeters, voltage adjusting potentiometers and an a-c failure alarm relay, and all have 24-hr adjustable timers. Exide Industrial Div., The Electric Storage Battery Co.

22—AIR MOTORS designed for heavy-duty applications

Five-cylinder, radial air motors in the new Pistonaire line are announced as combining high starting torque and sustained load-lugging ability with a simple throttle valve control that allows instant starts and stops, unlimited reversibility and infinitely variable speeds. Repeated overloads or stalls cannot harm them, says manufacturer, and they operate safely in explosive, damp, hot or corrosive atmospheres.

Ratings range from 11½ to 20 at 90 psi. Direct drive models turn at 400 to 800 rpm at rated horsepower with stall torques from 225 to 162 ft-lb. They are available NEMA D flanged; flanged with 15-in. diam bolt circle; and foot mounted. Weights are 230 to 289 lb. Geared drive foot-mounted models come in five gear reduction ratios from 4.1:1 to 21.5:1. Output shaft ranges from 19 to 200 rpm at rated horsepower, with stall torques of 4837 to 648 ft-lb are announced, with weights from 485 to 495 lb. Joy Mfg. Co.

23—POSITIONING SWITCH reduces control action lag

Faster and more reliable remote control of pneumatically-operated processes is possible with this positioning switch, manufacturer announces; it eliminates lags between switch and actuator mechanism. The switch is 20 per cent smaller than company's earlier models. It is used primarily for remote control of pneumatic valves or damper motors. Turning the knob increases or decreases flow of compressed air to these devices, opening or closing them to desired position. According to manufacturer, hysteresis, or the lag between a switch position change and corresponding air pressure change, is eliminated in this switch by use of a responsible ball valve instead of a needle valve. The switch is available for flush or surface mounting. Further information on the switch is provided in Bulletin 357–3 and Technical Data Form P-75. Powers Regulator Co.

24—BLOW-OFF VALVE for medium pressure service

The Yarway Unit Tandem Valve, for boiler blow-off pressures to 665 psi, basic rated pressure 400 psi, is announced as offering all features of the original Yarway Unit Tandem Blow-off Valve and at a competitive price. A

forged steel block forms a common body for both hard seat blowing valve and seatless sealing valve. The former is of the Welbond type with integral welded stellite seat. According to manufacturer, this design permits no leakage between seat and body. Valve stem is Type 303 stainless steel. Parts in the seatless sealing valve are interchangeable with company's Type B Seatless Blow-Off Valves. Tandem valves in the new medium pressure line are available with flanged or welding ends, right- or left-hand assembly Bulletin B-435, Supplement A provides details on these valves. Yarnall-Waring Co.

25—UNIT HEATERS, gas fired, available in 10 sizes

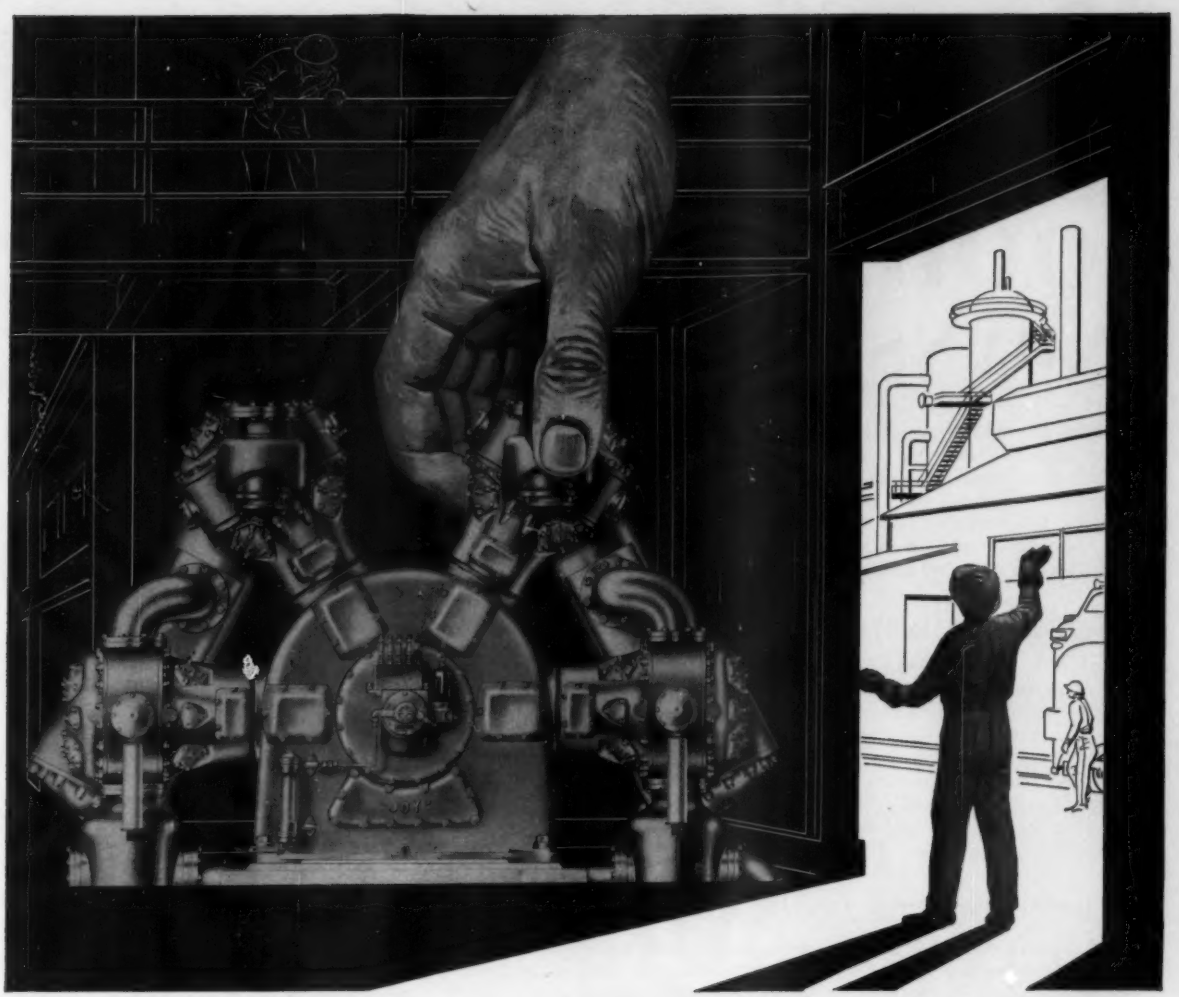
These unit heaters, in 10 sizes from 25,000 to 250,000 Btuh, incorporate a contoured aluminized steel heat exchanger design with combustion occurring within individual tubes for maximum heat transfer. They have automatic safety controls and are available for use with manufactured, natural, mixed, liquid petroleum gas and liquid petroleum gas-air mixtures. Cast-iron air adjustment shutters control primary air to the gas flame, and adjustable

20—PORTABLE KIT for low cost test of insulating oil

This portable oil test kit is offered for making on-the-spot checks of the condition of insulating oil in electrical apparatus. It offers a quick method of determining, right at the installation, the extent of sludging (acidity and polar contamination) in the oil. No technical training is necessary to make and interpret the tests, which, although claimed accurate, are not presumed to take the place of laboratory evaluation of the oil. Periodic spot checks determine when such laboratory tests are necessary, it is pointed out.

The kit costs around $15 and includes filter paper, medicine droppers, acidity indicator, buffer and polar compound indicator and instructions, supplied in steel carrying case. Tests are simple. A sample of oil is removed from the transformer and eye-dropped onto filter

paper, and the necessary indicator added. Comparison of the color and pattern of the spot with standard "spots" supplied in the kit shows the condition of the oil. Allis-Chalmers Mfg. Co.



SET A 500 TO 1000 HP AIR COMPRESSOR IN THE CORNER OF YOUR PLANT . . . *almost as easy as this*

IF YOUR EXPANDING PLANT FACILITIES are requiring more compressed air . . . *and* putting a squeeze on plant space, here's the answer . . . the *new* Joy WN-224 compressor. Because of its compact semi-radial design, the WN-224 is delivered as a package—completely assembled—ready to go. Just bolt it down, connect power, water, and air lines . . . and you're ready for long, continuous service. This is the only true "package" compressor available in these capacities . . . 2418 to 6048 cfm . . . horsepower ratings from 350 to 1000.

AND THE WN-224 SOLVES YOUR SPACE PROBLEMS . . . it can be installed where no other compressor of equal capacity will fit. Instead of long, horizontal units on massive foundations, the Joy WN-224 has four cylinders arranged semi-radially around the frame. This compact, balanced arrangement assures smoother running, gives longer service with far less maintenance. Get the whole story on the WN-224 from ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

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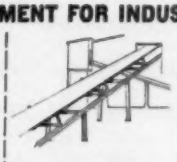
JOY . . . EQUIPMENT FOR INDUSTRIAL PLANTS . . . FOR ALL INDUSTRY

Industrial Compressors


Conveyors

Electrical Connectors

Fans and Blowers

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CHECK *the Advantages of* GOODALL *Rubber* EXPANSION JOINTS

Goodall Expansion Joints have not only the advantages stemming from the natural characteristics of rubber for all types of installations, but, what's more important, they have back of them Goodall's engineering skill, manufacturing experience and reputation for quality that give added assurance of exceptional service under all conditions.

EASIER TO INSTALL...

Goodall Rubber Expansion Joints are quickly, easily installed on new construction or as replacements. They are light in weight to facilitate handling, with short face-to-face dimensions for easier application where space is limited. Retaining rings are quickly aligned and bolted. No gaskets are required.

RESPONSIVE TO MINIMUM PRESSURE...

With Goodall Rubber Expansion Joints only the slightest pressure is required to create movement in any direction. Result—stress on metal pipe or other member is eliminated or, at most, reduced to an absolute minimum.

MANY SIZES...HIGH WORKING PRESSURES...

Goodall Rubber Expansion Joints are available in sizes from ⅜" to 96" I.D., in all required styles and constructions. Working pressures range up to 125 P.S.I. for Pressure Joints, and to 90 P.S.I. for Vacuum-Pressure Joints, depending on size.

LONGER SERVICE LIFE...

Goodall Rubber Expansion Joints last longer in service because of inherent characteristics of the material from which they are made. There is no embrittlement... continuous movement (flexing) actually keeps the rubber joint "alive". There is no corrosion or electrolysis. Resistance to abrasion is exceptionally high. Replacement costs are lower.

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GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

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For more data circle 544 on Post Card

louvers permit variation of discharge air to suit installation requirements. Fan motors are rated at 115-v, 60-cycle, single-phase current and have automatic reset-type thermal overload protection. The seven smaller units have a permanent lubricated shaded-pole motor, the larger units, permanent capacitor motors requiring lubrication. Sturtevant Div., Westinghouse Electric Corp.

26—STAINLESS GATE VALVE fitted with a split wedge

Made of Types 316 and J-20 alloys suited to a wide range of corrosive conditions, these valves are fitted with a split wedge of ball-and-socket design which automatically adjusts to the tapered seating surfaces. The discs, revolving freely in the wedge carrier, produce a self-cleaning action on the seat which is claimed to reduce possibility of galling and seizing. Among other features are two-piece packing gland design said to eliminate binding of the follower when gland bolts are tightened unevenly, and chevron-type Teflon packing, body of through-port design. Size range of the 150-lb flanged end valve, Fig. 1327, is from ½ to 8 in.; of the 200-lb screwed end valve, and the Fig. 1326 valve, from ½ to 2 in. Jenkins Bros.

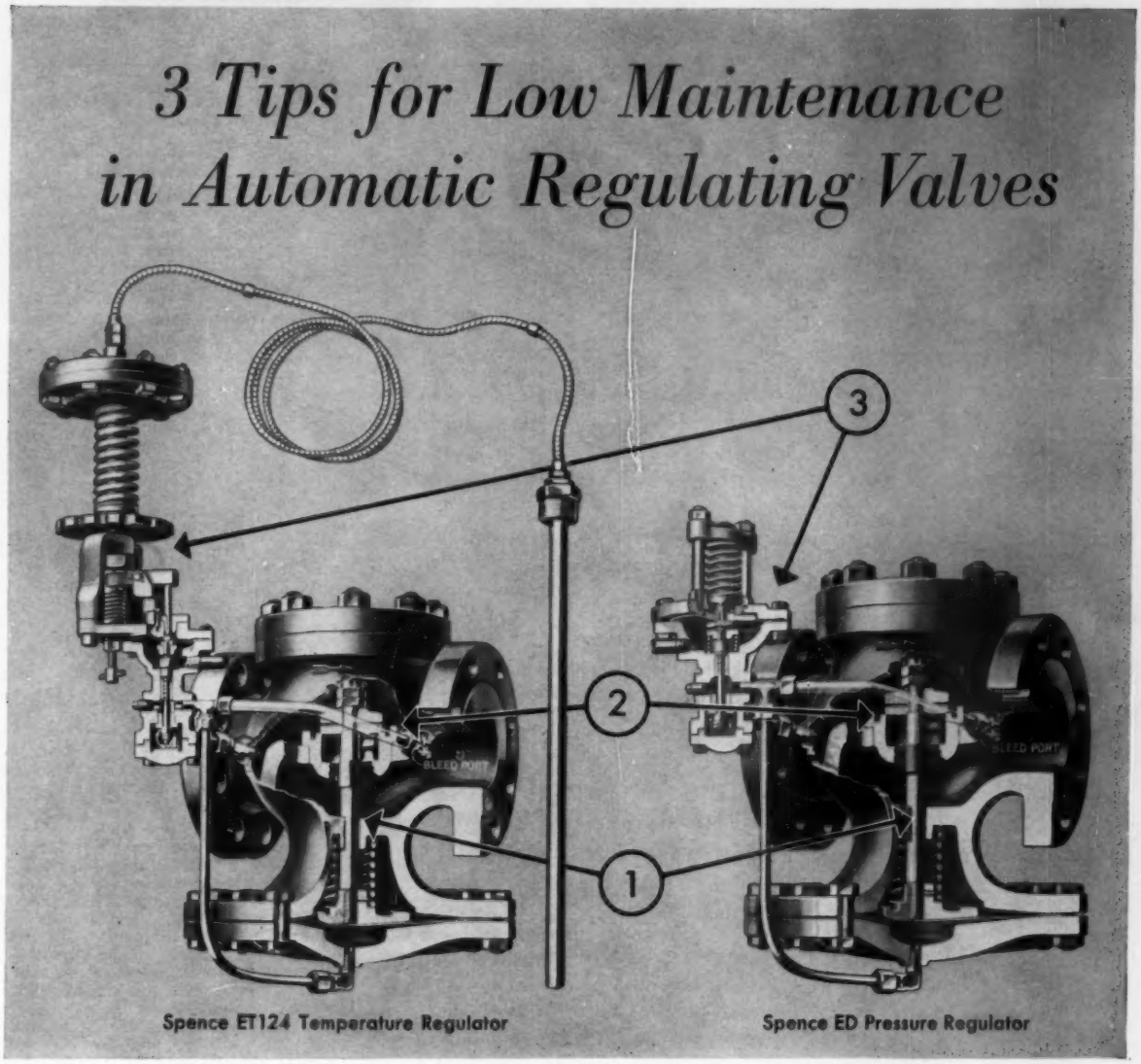
27—LIQUID ALUMINUM casts without heat or pressure

Devcon F-2, is announced as a liquid aluminum, similar to company's Devcon F, an aluminum putty containing 20 per cent plastic. Devcon F-2 becomes liquid upon the addition of a hardening agent, manufacturer states, and 2 hr afterward the material becomes a durable, metallic mass similar in appearance to aluminum or steel. Devcon F-2 is reported to have excellent physical

properties (compression strength 20,000 psi) and to be unaffected by most oils, chemicals and solvents. It bonds aluminum, steel, bronze, wood, ceramic and other materials to itself or to each other, company notes. It is described as non-shrinking and non-expanding and as having good abrasion resistance. It can be drilled, tapped or otherwise machined with metal-working tools. Application suggestions include filling of holes

VALVE TIPS:

3 Tips for Low Maintenance in Automatic Regulating Valves



Spence ET124 Temperature Regulator

Spence ED Pressure Regulator

No engineer has to be told that downtime of regulating valves is costly—and a nuisance.

Nowadays the men who keep these valves operating want to make sure they aren't stuck with a maintenance headache for the life of their valves. That's why we are outlining this simple check list which covers three important features which keep maintenance costs down.

1. Stuffing boxes are probably the number one time consumer in valve maintenance. No matter how you figure it, repacking stuffing boxes is costly.

That's one reason Spence uses a "balanced" diaphragm construction which eliminates stuffing boxes. Simple stem guiding and large metal diaphragm operation reduce sticking and binding to a minimum.

2. Another problem is replacement of seats and discs when they've been cut by steam. Today you can forget about this problem entirely by insisting on an unconditional guarantee against wiredrawing. Spence, for instance, uses SECO Metal seats and discs and gives such a guarantee.

3. Any valve designed to control temperature and pressure within tight limits can be affected by dirt in the steam lines. You can't get a guarantee against this, but you can specify a valve that makes trouble shooting easy. Here's the tip:

Make sure your regulating valve is controlled by an external pilot. If trouble develops, it is easy to find out if it is in the pilot or the main valve with a simple test.

If the trouble is in the pilot, you can remove it without taking the main valve out of the line.

The quickest way to get the regulator working again is to install a spare pilot. This is easy—and in the Spence design it is not expensive to carry spare pilots. Spence pilots fit all sizes of Spence main valves.

These maintenance advantages plus other advanced features are available in a wide range of Spence automatic regulating valves. For more information write for the Bulletin TE.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

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By their periodic use, and from the records of their measurements of the insulation in all important equipment, trouble may be anticipated and avoided, and production stoppage and losses reduced.

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Over forty years of experience in the field of electrical testing is represented in the manuals, bulletins, and other technical literature published by the Biddle Company. These are some of the extras you get with your purchase of a Megger Instrument. Practical engineering assistance is always available without obligation.

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A collection of reference material designed to be helpful in setting up and interpreting a practical testing program may be had for the asking—request File 21-PE.

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in castings and holes drilled incorrectly, and building up of worn sections on cast or machined parts. Trial kit containing four 1-b units and necessary components costs under $12. Devcon Corp.

Reader Service Cards on pages 113–114 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

28—CONTROL BY-PASS lets operator "take over" temporarily

For use with company's indicating pneumatic controllers, this four-position control by-pass is offered as an option with the USG Pilot, a controller which can be used for temperature, pressure, liquid level and other process variable applications. Its prime function is to provide a means of cutting off controller air to

valve (or damper etc.) and for positioning the valve manually, as may be necessary during process start-ups, process upsets requiring manual rebalancing, servicing of controller etc. The unit is designed to permit "bumpless" transfer from manual to automatic control — letting the operator match output pressures from controller and manual regulator so that no difference exists.

The four switch positions of the control by-pass are: service position; test position; manual position (for normal manual control applications); and automatic position (for normal automatic control). One indicating gage on the switch panel serves for comparison and matching of the two output signals. United States Gauge, Div., American Machine and Metals, Inc.

29—SOLID FILM LUBE operates in oil, and grease

Claimed to increase the wear life of moving parts operating in oil and grease, this solid film lubricant, No. 4856, has two distinguishing features. First, it contains small particles of lead, tin and graphite, known for ability as bearing materials. Second, its semi-porous nature absorbs oil and acts as a reservoir against metal-to-metal contact under high loads and especially during long shutdown periods, manufacturer points out, and it is compatible with additives in modern oils and greases. Bulletin 2056 gives details. Electrofils, Inc.

J&L welded boiler tubing is being used by Wickes Boiler Co. for a wide variety of products, including these boiler pressure assemblies.

"We can rely on J&L welded boiler tubes to have uniformly sound physical properties"

"They meet all of our rigid production and quality control requirements," says Wickes Boiler Company official

The Wickes Boiler Company of Saginaw, Mich., a division of the Wickes Corp., has found J&L electric-resistance-welded pressure tubing to be well adapted to its needs, reports D. H. Barnes, division president. J&L boiler tubing has been used in a wide variety of Wickes products, including the newest Wickes Type-A water tube steam generator, the largest shop assembled generator of its type ever built. This generator is now in use in a large steel plant.

Wickes has custom-designed and built boilers—featuring J&L pressure tubing—for a variety of installations, including hospitals and chemical refineries, schools and automotive plants, military posts and food processors.

If your firm makes a product involving pressure tubing, investigate J&L's service-proven steel tubing. J&L pressure tubing has been used for closed-type feedwater heaters, industrial hot water heaters, cooling water heat exchangers, and package steam generators, to mention only a few applications.

For more information, call your J&L representative. Or write to Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa.

Uniformly sound physical properties in J&L welded boiler tubing eliminate bending problems and assure trouble-free assembly of tubular components.

The exciting new J&L

Jones & Laughlin Steel Corporation

PITTSBURGH, PENNSYLVANIA

STEEL

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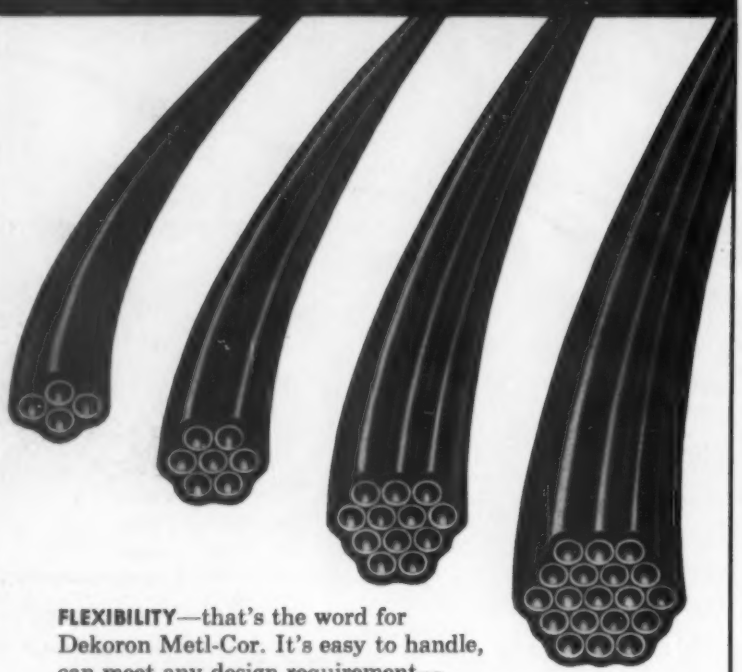
DEKORON METL-COR
MULTIPLE TUBE HARNESS

cuts installation costs
bends without distortion
solves instrument line corrosion problems



FLEXIBILITY—that's the word for Dekoron Metl-Cor. It's easy to handle, can meet any design requirement—and it's highly corrosion resistant, too.

FIRST, Metl-Cor's exclusive Extru-Loc construction makes it easy to bend with no tube distortion.

SECOND, the Metl-Cor design is flexible. You can specify Metl-Cor with core tubes in either copper or aluminum . . . in any standard or special OD or wall thickness . . . with almost any number of tubes in each bundle.

MOST IMPORTANT, no matter which type or size you specify—you get all the inherent cost-cutting savings and longer life that you pay for.

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Dekoron® products
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American Power Conference

continued from page 77

The Economics of Air Preheat on Industrial Boilers, by Charles L. Brown; New Developments in Fuel Burning Equipment for Industrial Boilers, by A. W. Jackson; Solving Maintenance Problems — a panel discussion.

An electrical industrial session will present a symposium on training of personnel in maintenance of complex electrical controls.

Peaking Service: Automatic Plants for Peaking, by Eugene W. Kettering and B. H. Hefner; Design Concepts of a Low-Cost Gas Turbine Generating Plant for Peak Load Service, by A. O. White and R. J. Carpenter.

Protection: Lightning Protection for Electrical Equipment — Development and Present Status, by H. R. Armstrong; Shielding Practices for Medium Voltage Cables, by J. E. Maher.

Nuclear Power Plants: Power Reactor Safeguards, by Robert H. Shannon; A Design Code for Power Reactors, by David B. Singer; Pebble Bed Reactor, by S. T. Robinson and R. F. Benenati; Industrial Development of Boiling Water Reactors for the Generation of Competitive Nuclear Power, by R. B. Richards; A 150-Mw Organic Moderated Reactor Power Plant, by Ralph Balent.

Circuit Breakers Without Oil: High Voltage Airblast Circuit Breakers, by W. B. Wilson and R. B. Shores; Gas-Filled High Voltage, High Capacity Circuit Breaker, by R. E. Friedrich.

Feedwater Circuits: Thermal Density Currents and Their Utilization in Condensing Water Design, by Rex Elder; Velocity Versus Pipe Size in Feedwater Systems, by L. H. Carr; Condenser Arrangement for Dumping Large Quantities of Steam, by R. A. Wilson.

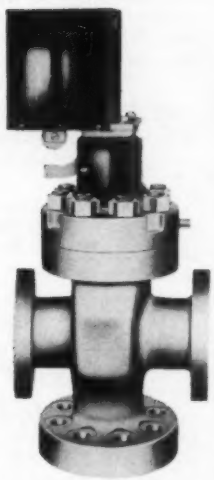
Computers and Network Analyzers: Computers as Aids to Power System Analysis, by Charles Concordia and F. J. Maginniss; Simplified Digital Short-Circuit Solution of Power System Networks, by Martin J. Lantz; Patchboards on Network Analyzers, by John I. Ykema; New Equipment for Network Analyzer Operation, by L. E. Lingo; Recent Improvements on the Network Analyzer; by P. M. Anderson; Network Analyzer Installations in Canada and the United States, by Eric T. B. Gross.

Electric Space Heating: Experiences with Commercial and Industrial Heating with Electricity, by G. Gill; Residential Electric Heating, by J. H. K. Shannahan.

Electric Distribution: Providing Underground Service for Residential Areas with Electric Heating, by H. D. Ely, D. P. Jenkins and H. W. Oerman; Positive Planning in Distribution, by Charles E. Flahie.

PRESSURE LOADED SEATING

minimizes leakage and maintenance



Consolidated Electromatic Relief Valve. Sizes: 2½" to 14". Pressures to 3000 psi. Temperatures to 1120°F. Double Outlet.

Consolidated Electromatic® Relief Valves save steam, pure water, fuel, and "wear and tear" on your spring-loaded valves. Pressure loaded seating permits closer adjustment between operating pressure and set point than in spring-loaded valves. Many Electromatics are used to purge superheaters for faster startups and as superheater vent valves. They greatly reduce chances of superheater damage when firing up a cold steam generator or banked boiler.

Pressure loaded seating is created by channeling steam from the pressure vessel around the Electromatic's exhaust and into its main and pilot valve chambers. Steam pressure in both chambers always matches that in the vessel when the Electromatic is closed.

When pressure exceeds the Electromatic's set point, a signal from controller to panelboard control station results in solenoid thrust that opens the pilot valve, venting the steam faster than it can enter the pilot valve chamber through the clearance between the main valve disc and guide. With pressure in the chambers unbalanced, the main valve opens; steam exhausts until boiler pressure is reduced to the pre-determined setting of the controller. The pilot valve and the main valve close instantly at this point. Action is so fast, the closely adjusted Consolidated Electromatic normally relieves overpressure before the spring-loaded valve's set point is reached. For automatic or manual operation or to cut the valve out of service, a switch is provided on the control station. Send for Bulletin 720.

MAXWELL MANNING M&M MOORE INC. TRADE MARK

CONSOLIDATED SAFETY VALVES

A product of

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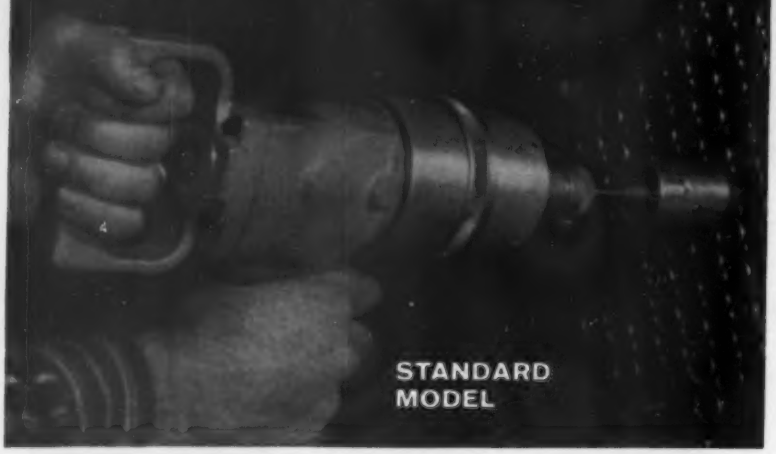
ELLIOTT air magnetic tube expander drives

automatically controlled for fast, accurate tube rolling



Designed for faster, precision tube rolling, the standard model Elliott Air-Magnetic drive is setting new records for speed and accuracy. Some operators average 12 tubes per minute. Desired torque easily preset by rotating forward end of unit. No tools needed. Rolling stops when preset torque levels are reached. Includes trigger-controlled, explosion-proof air motor in single unit. Magnetic control, no springs. Balanced for easy handling. For tubes ¼ in. through 3 in. *Standard model* handles most jobs. *Heavy-duty* for higher torque.

ALSO Electric Control ... Tube Expanders ... and Related Accessories

Elliott offers the Automatic Electric Control—an accurate torque-limiting device designed for tube expanding with any standard tapping motor. Also, a complete line of tube expanders, with rotating, parallel, self-feeding rolls. Available in 4 sizes, ranging from ¼ in. to 3½ in. O.D.

***Other related accessories* include Elliott tube gage, tube plugs, tube pilot, and tube rolling lubricant.**

Write for descriptive literature *today*.

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ELLIOTT Company
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NEW ENGINEERING BOOKS

Marks' Mechanical Engineers' Handbook, Sixth Edition, prepared by a staff of specialists, revised by Theodore Baumeister, Editor-in-Chief. 2270 pages, 6 x 9 in. Published by McGraw-Hill Book Co, 327 W. 41st St, New York 36, N. Y. Price $23.50.

In view of the rapid rate of technical progress, the updating of this well-known handbook is extremely important and valuable. In easy-to-find form and clear, concise style, it presents complete information on the fundamentals of every branch of mechanical engineering.

In the fields where the most progress has been made, entire revisions have been affected, or whole sections added. These subjects include: Mechanics of materials, Numerical analysis and computing machines, Vibrations, Aerodynamics, Jet propulsion, Atomic power, Automobiles, Steam boilers, Instruments and controls, Railway engineering, Aircraft propellers, Corrosion, Industrial engineering, Turbo compressors, Gas turbines, Displacement pumps, Fans, Pipe and pipe fittings, Lubricants and lubrication, Structural design of buildings, and Welding.

These discussions as well as authoritative reports on the status of all the other phases of mechanical engineering make this handbook a must for every complete engineering library.

★ ★ ★

Maintenance Hints, 585 pages, 5½ x 7½ ins., plastic binding, loose-leaf. Published by Westinghouse Electric Corp, Pittsburgh, Pa. 1958. Price $2.00

Here is a quick-reference manual on electrical equipment maintenance which gives general data on motors, starters, controllers, transformers, breakers, and other items found in most every plant.

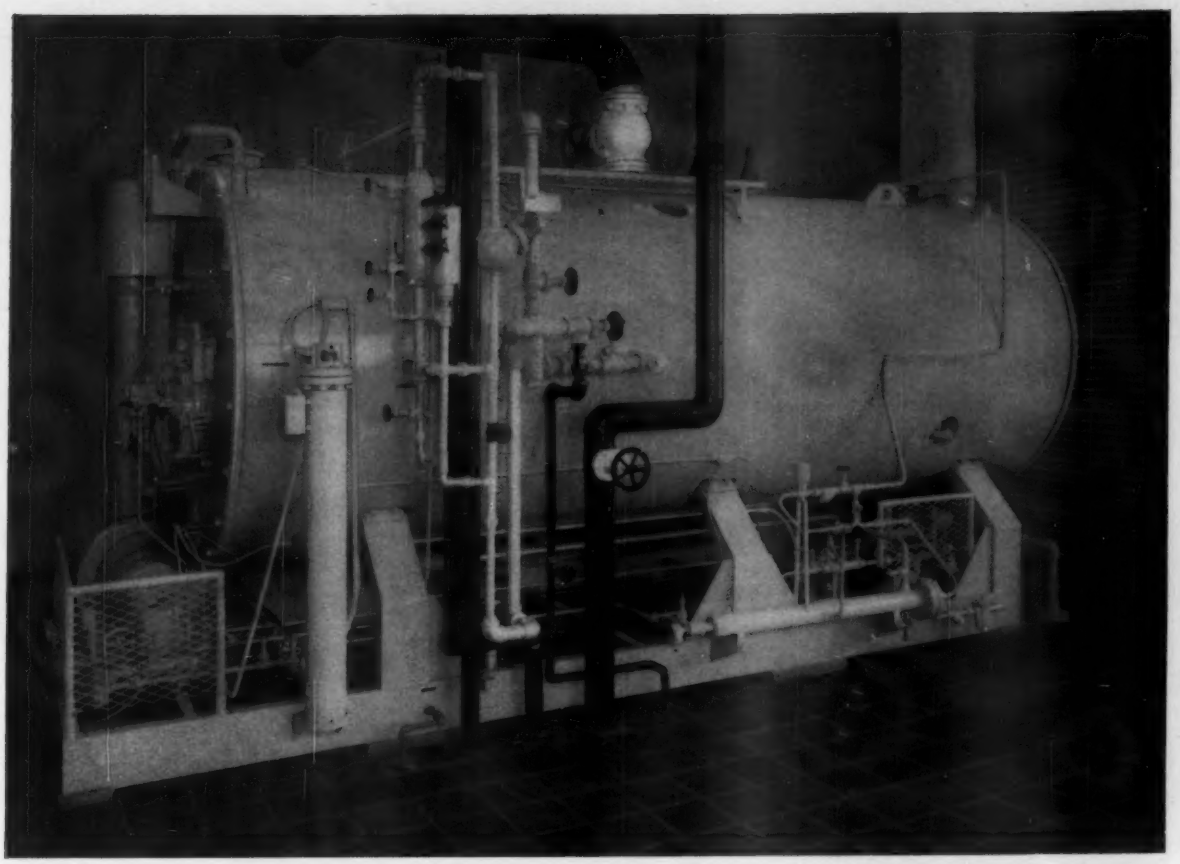
This manual is divided into 24 chapters, which makes for easy subject location. The text is easy to read, and diagrams are clear and concise.

In addition to the maintenance instructions and tips, the book contains some very good check-charts and tables pertinent to the subject. These include much data, in condensed form, which would otherwise have to be obtained from a number of sources.

Written in practical, not-too-technical language, this manual is based on many years of experience gained from actual operation of equipment in the field.

Of importance to power men who are acquiring more and more electronic equipment in their plants, is the chapter on Industrial Electronics.

Power engineers will find this volume equally valuable in the shop or for general office use. ***continued on page 108***



200 HP AMESTEAM GENERATOR Installation at U. S. Concrete Pipe Co.

LOW COST STEAM DELIVERED BY AMESTEAM GENERATORS BRINGS REPEAT ORDERS FROM U. S. CONCRETE PIPE

Why is it that AMESTEAM GENERATOR customers are almost always *repeat* customers? The reason can be summed up in these words: "Lower Cost Steam". One of these repeat customers is U. S. Concrete Pipe Co., Relay, Md. This firm is one of the leading producers of large concrete drainage pipe and allied products.

Recently the company needed a boiler to supply steam for the structural curing of various concrete products. Successful experience with the AMESTEAM GENERATOR "Package" Boilers proved elsewhere in other plant operations led to selection of the 200 HP unit shown above. U. S. Concrete Pipe found that this AMESTEAM GENERATOR provides the most economical and efficient solution to this important steam problem.

Here is another of the hundreds of users whose complete satisfaction with AMESTEAM's low-cost, dependable performance is indicated by the repeat orders we continue to receive from them. This record for repeat orders is based on AMESTEAM GENERATOR's reputation for *Low Cost Steam*, faithfully delivered over a long period of years.

What's YOUR Steam Problem?

If you need 10 to 600 HP and want the kind of space-saving, trouble-free service enjoyed by satisfied owners of AMESTEAM GENERATORS, write today for our catalog and the name of your nearby Amesteam Dealer.

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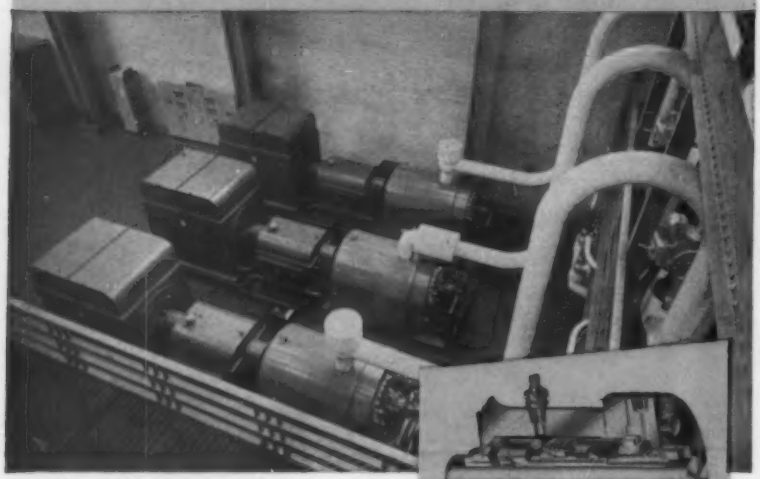
John Crane BOILER FEED PUMP SEALS
are BRINGING NEW ECONOMY
TO INDUSTRY and UTILITIES



It will be worth your while to get full information about "John Crane" Seals for your high temperature, high pressure boiler feed pumps. At numerous installations they are setting records in the saving of maintenance, feed water and kilowatt costs.

Get detailed data by requesting our Bulletin S-230. At the same time we will give facts and figures on installations now in operation.

On letterhead request, we will furnish a complete layout to meet your pump requirements. Give us make, model and serial number of your pump, plus temperatures, suction and discharge pressures.

Important Economies for Other Hot Water Service, Too!

If you are operating a power plant, boiler room, industrial or commercial hot water pump system, Bulletin S-230 can help you. Contents include full details on hot water shaft seals that offer the same cost savings as boiler pump feed seals.

Crane Packing Company, 6429 Oakton Street, Morton Grove, Ill., (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

CRANE PACKING COMPANY

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Engineering Books

continued from page 106

Water Power Engineering, by Holt Hammond. Size 5½ by 8½ in., 302 pages. Published in London by Heywood & Co, it is distributed in the U. S. by The MacMillan Co, 60 Fifth Ave, New York, N. Y. Price $10.00.

An essentially practical approach to the field of hydroelectric power, the book is presented in five chapters: The Water Power Industry, Water Turbine Design, Electrical Problems, Hydroelectric Developments and Tidal Power. There are 292 illustrations covering hydroelectric projects all over the world, including the "pumped storage" project in Scotland. In the survey of the industry, the author discusses the relative importance of water power, planning schemes, underground power stations, geological factors such as stresses in rocks, and the relationship between water and nuclear power. The main types of turbine are considered with emphasis on the importance of full scale and model tests.

The fourth chapter contains a number of case histories in the more important hydroelectric developments currently in operation or in process of construction. The final chapter on tidal power is a hypothesis treating with the future of the subject and full consideration is given to existing French plans for such development.

* * *

Elements of Heat Transfer, by Max Jakob and George A. Hawkins. Third Edition. 317 pages, 6¼ by 9¼, cloth bound. Published by John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y. Price $6.75.

Still emphasizing basic principles and their applications to simple problems, this edition contains new material not included in its predecessor. A new table on thermal conductivity of liquid metals, an added section on the use of equivalent circuits for the solution of problems, and considerable material related to heat transfer in nuclear reactors are among those features added.

Fundamental modes of heat transfer are presented, followed by discussions of the conditions arising when two or more modes are involved. All cases are illustrated by easy-to-follow examples.

* * *

Mechanical Engineering Laboratory, by Charles W. Messersmith, Cecil F. Warner, and Robert A. Olsen. Second Edition, 1958. 179 pages, 8½ by 11, spiral bound. Published by John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y. Price $5.50.

A comprehensive description of a time-tested series of laboratory experiments at the college under-graduate level, this book may be used as an excellent review of basic principles underlying all phases of mechanical engineering. Also included is a section of general instructions applicable to laboratory use.

continued on page 110

Salk Hall and campus photo courtesy of University of Pittsburgh.

Famous

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at the University of Pittsburgh to be serviced by Ric-wiL underground piping . . .

Salk Hall is where Dr. Jonas E. Salk and his staff are conducting their continuous virus studies. This ten-story building will eventually become a center for experimental medicine with additional space for research conducted by many faculty members.

Ric-wiL is proud to be a part of this great institution and has, since 1932, supplied the underground steam distribution lines. Over 10,000 feet of Ric-wiL serves an area more than a half-mile long and a half-mile wide.

Over 500 universities, colleges and schools are presently using Ric-wiL Piping Systems.

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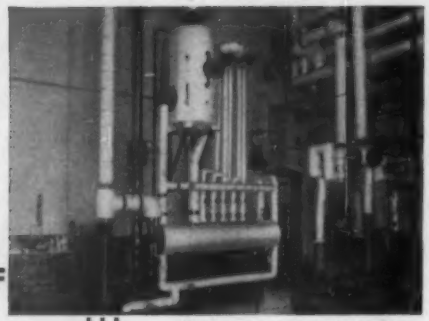

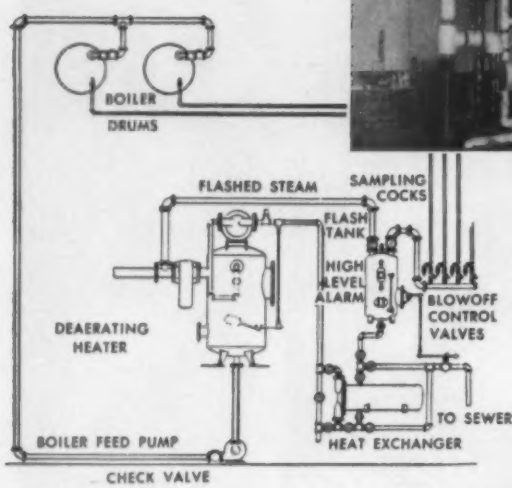

Photograph and drawing showing installation of a Cochrane Class I Continuous Blowoff System of the type most frequently encountered. This sytem is recommended for use where heat recovered from the Cochrane Continuous Blowoff System does not exceed the rating of the feedwater heater.

Here are some typical savings with a **Cochrane**

CONTINUOUS BLOWOFF SYSTEM

- **A Utility: $15,400.00 annually**
- **A Sugar Refinery: 3,500.00 annually**
- **A Power Plant: 6,700.00 annually**
- **A Packing Company: 1,500.00 in first year**

(Names of companies on request)

Rising power plant operating costs make complete utilization of heat more important to your company than ever before. With a Cochrane system you can recover practically *all of the heat of the blowoff*. Both flashed steam and heat from hot waste water are returned to the feedwater system.

In addition, Continuous Blowoff provides more uniform boiler concentrations, smoother boiling conditions and cleaner steam.

Cochrane Corporation designs and manufactures complete lines of deaeration, precipitation, ion exchange and water conditioning equipment. Call Cochrane first for water treatment.

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Representatives in thirty-two principal cities in U.S., Hawaii, Puerto Rico; also, Havana, Cuba; Paris, France; La Spezia, Italy; Mexico City, Mexico; Caracas, Venezuela; Santiago, Chile; Manila, Philippine Islands.

Pottstown Metal Products Division—Custom built carbon steel and alloy products.

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Engineering Books

continued from page 108

Steam Turbine Performance and Economics, by Robert L. Bartlett. Size 6 by 9 in., 317 pages. Published by McGraw-Hill, 330 W 42nd st, New York 36, N. Y. Price, $12.50.

Author has been both design and application engineer in the Turbine Engineering Section, Large Steam Turbine-Generator Department of General Electric Co.

Intended for use as a guidebook and reference in calculating steam power plant performance and its applications in preparing economic studies, this volume includes procedures helpful to the power plant designer in selecting large turbines to meet specific needs.

All important developments in the field of turbine design are covered, including advanced steam conditions, largest sizes and data on turbine performance. Book also covers extensive information on performance of single reheat and double reheat cycles and combined cycles, together with important material on supercritical pressure and temperatures above those in current use. Discussion of equipment, operating and investment costs and cost of steam power plants is included.

Volume is more important to the engineer interested in answers than methods. Performance comparisons are given in graph form. Methods and background material are also given for those who would use this performance data to make economic evaluations for design and applications studies.

* * *

Compact Heat Exchangers, by W. M. Kays and A. L. London, Stanford University, 156 pages 8¼ by 11 in., cloth. Published by McGraw-Hill Book Co, 327 W. 41st St., New York 36, N. Y. Price $6.00.

The authors, professors of mechanical engineering at Stanford University, have presented a comprehensive treatment of compact heat transfer surfaces, including all of the types in use today. Types of surface dealt with are: 1. tube banks, including both circular and flattened tubes, with both inside and outside flow; 2. plate-fin surfaces with a variety of fin types; 3. finned tube surfaces with both circular and flat tubes and various types of fins; and 4. screen and sphere matrix surfaces. In all, basic heat transfer and flow friction test data are presented for a total of 88 surface configurations.

In addition, the authors present a number of analytical solutions for abstract contraction and expansion pressure-loss coefficients, laminar-flow heat transfer in circular and rectangular tubes and the effects of temperature-dependent field properties on heat transfer and flow friction.

Dowex:: ION Exchange, compiled and published by The Dow Chemical Company, Midland, Mich. 75 pages, 6 by 9¼ in., cloth. Available to company departmental

libraries when request is made on letterhead to Engineering Chemical Sales, The Dow Chemical Co, Midland, Mich.

Book is intended for use by the process engineer and laboratory scientist seeking a ready reference on ion exchange technology. Application techniques in chemical processing are described, with illustrations of laboratory equipment used.

Types and properties of ion-exchange resins, ion-exclusion and ion-retardation are also presented in the book. Characteristics and physical properties of resin beads are also described.

Book is provided to help both established ion exchange users and those who may find use of ion exchange principles a solution to production problems.

* * *

Field Inspection of Building Construction, by Thomas H. McKaig. 337 pages, 6 by 9 in., 7 chapters. Published by F. W. Dodge Corp, 119 W 40th street, New York 28, N. Y. Price $9.35.

This is a comprehensive handbook on the supervision of building construction by the architect, engineer, and the field inspector. Written by the head of the well-known Buffalo consulting engineering firm that bears the authors name, the book charts a clear path through the maze of owner-architect-engineer-contractor-subcontractor relations.

The book defines and explains responsibilities for such matters as quality of materials, quality of workmanship, coordination of work by different trades, schedules, storage of materials, provision of utilities and services, safeguarding of work in place, safety precautions and other vital functions.

Seven exhaustive chapters, beginning with a discussion of the job of the inspector, cover in detail every phase of construction: the preliminary stage, foundation stage, structural framing stage, intermediate stage, and the finishing stage. Because of the complex problem of inspecting concrete work, a special chapter is devoted to this material.

This volume gives practical guidance in safeguarding the owners interests against a variety of contingencies, without exposing him to charges and possible claims for interference or delay. This is often a very fine line, and the author knows and reveals it well.

* * *

Construction Accounting and Financial Management, by William E. Coombs. First Edition, 1958. 481 pages, 6 x 9 in., cloth binding. Published by F. W. Dodge Corp, New York. Price $12.85.

Every power engineer who is responsible for any amount of construction or alteration work will find this an invaluable text.

Starting with the original design concept, the author explains in understandable language how to keep the job on a sound basis.

Covered in detail are such subjects as subcontracting procedures, purchasing, change orders, financial statements, cost-control and insurance.

Cochrane

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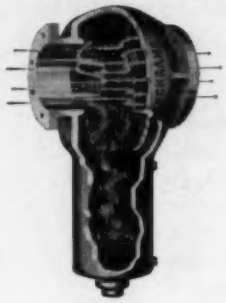

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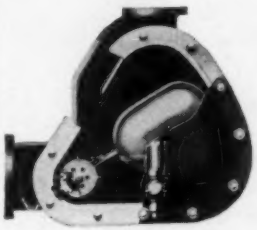

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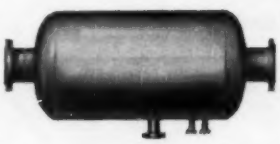

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facts about Superior Packaged Boilers

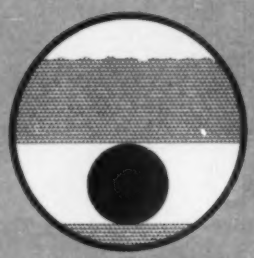
SUPERIOR'S MID-SHELL FURNACE LOCATION

protects against the two most common causes of furnace failure

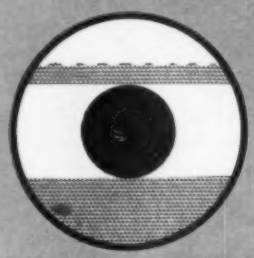
One of the often overlooked, and yet very important considerations for the purchaser or specifier of boilers of the horizontal fire-tube type is the location of the furnace in relation to the boiler shell. To a great extent this location is determined by whether the boiler is of the up-draft or down-draft type. Up-draft units usually have the furnace set low inside the shell. Down-draft units usually have a higher furnace location.

Ideally the furnace is located near the center of the shell, where it is protected from the two most common dangers which can cause bagging, blistering or complete burnout of the furnace.

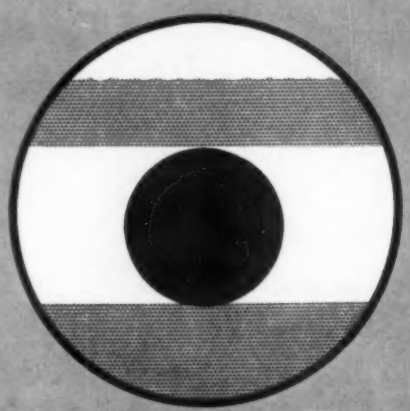
The first of these dangers is low-water. When the furnace is located too high in the shell, the covering layer of water is necessarily less, and the danger is increased. When the furnace is too low within the shell, mud and silt can deposit on the bottom of the shell and eventually bridge to the bottom of the furnace, cutting off circulation and causing a burnout of the furnace. The adjacent diagrams show the location of the furnace in other fire-tube boilers and in Superior Type C boilers. When you buy or specify a packaged fire-tube boiler consider this important fact.



LOW FURNACE...MUD BURNOUT DANGER



HIGH FURNACE...LOW WATER BURNOUT DANGER



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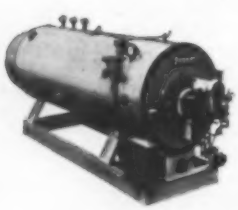

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WATER CONDITIONING

201 **Handbook on Demineralizing** — Comprehensive 40-pp Bulletin 5800 compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use two-bed, three-bed, four-bed, mixed or mono-bed demineralizers. It also indicates when decarbonators or vacuum deaerators should be installed. Cochrane Corp.

202 **Demineralization Data** — Bulletin WC-111A, 32 pp, is company's revised booklet on demineralization (ion exchange). In addition to basic sections on application of demineralizers, principles of operation and chemistry of ion exchange resins, this bulletin includes detailed information and charts on design and materials of construction. Includes comparison charts on multi-bed, mixed-bed and scavenger or polishing demineralizers. Detailed layouts of each type of system are provided. Graver Water Conditioning Co.

203 **Evaluating Steam Purity** — Technical Paper 135, entitled "Conductivity vs Sodium by Flame Spectrophotometry In Steam-Purity Studies," discusses results of laboratory and plant work to indicate that sodium is extremely valuable in evaluating steam purity. Performance curves are included in the paper. Betz Laboratories, Inc.

204 **Boiler Water Treatment** — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 10-pp Bulletin BW. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details are covered. A bibliography lists supplementary reading. Fairmont Chemical Co., Inc.

205 **Corrosion Inhibitor** — Bulletin 420-12-9 describes manufacturer's Composition TG, a sodium-zinc hexametaphosphate corrosion inhibitor for water systems, stressing its superiority in controlling corrosion in water mains and cooling equipment. Provides comparative graphs showing flow coefficients, rate of film formation as determined by weight loss and current flow, and schematic drawings of feeding methods. Calgon Co., Hagan Chemicals & Controls, Inc.

206 **Valveless Filter** — Operation of company's automatic valveless filter is described in 8-pp illustrated Bulletin 4351. Applications and typical operating conditions are detailed and diagrams and photos are included. The Permutit Co.

208 **pH and Chlorine Control** — The 13th, 1957 edition of company's handbook, "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination

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210 Feedwater Heaters—Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. They cover capacities from 3000 to 300,000 lb per hour. Stickle Steam Specialties Co.

212 Consulting Service — Advantages of company's consulting service are detailed in 8-pp Bulletin 5006-A. How the service is qualified to solve problems concerning scale and corrosion control in boilers, cooling systems, and process waters is discussed. Dearborn Chemical Co.

VALVES, TRAPS, AND PIPING

215 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations, describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Edward Valves, Inc.

216 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics covered. Crane Co.

218 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. The Henry Pratt Co.

219 Reducing Valves — Direct-operated water pressure reducing valves are featured in illustrated Bulletin 1009. A cutaway view showing component features is included, as well as water capacity table, dimensional tables and diagrams. Spence Engineering Co., Inc.

221 For Lightest Condensate Loads — Bulletin T1744 (58) describes company's No. 30 impulse steam trap for use where condensate must be handled in very small amounts. Lists advantages and applications, tells how trap works and gives capacities, dimensions, materials used, prices. Yarnall-Waring Co.

223 Steam Trap Book — Catalog K 48-pp is a manual of steam trapping practice. It includes a section giving physical data and prices on OF & T traps, cast semi-steel and forged steel inverted bucket steam traps, compound traps, ball float air and air relief traps. A handbook section

explains how to calculate condensate load and select traps for all classes of equipment; a maintenance section explains trap installation, testing, and maintenance. Armstrong Machine Works.

224 Materials for Main Steam Piping — Entitled "The Plastic Ductility of Austentic Piping Containing Welded Joints At 1200 F," this 16-pp bulletin deals with an investigation into the problem of selection of materials for main steam piping. Gives stress rupture characteristics of type 316 and 347 stainless steel piping adjacent to welded joints. Pittsburgh Piping and Equipment Co.

225 Industrial Expansion Joints — Advantages of company's line of industrial expansion joints designed for rugged temperature and pressure extremes are detailed in this illustrated brochure. Typical applications are pictured. Solar Aircraft Co.

226 Ball Joints — How to solve piping flexibility problems with company's ball joints is explained in illustrated Bulletin 31. Thermal expansion and contraction principle is illustrated and described and typical examples given. Barco Mfg. Co.

228 Pipeline Strainer—Bulletin 1210B describes a line of self-cleaning semi-steel pipeline strainers in sizes from ¼ through 3 in. Construction features are detailed and dimensional data, weights and prices tabulated. Sarco Co., Inc.

BOILERS, GENERATORS

230 Fire Tube Boilers — This 12-pp catalog describes Superior Compact packaged boilers in capacities from 20 to 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features of the units. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

231 Package Boilers — This 12-pp booklet on package steam generators describes the formulas behind all package steam generators, and illustrates how installation of a package steam generator can raise steam capacity in an existing boiler room. Cyclotherm Div., National-U. S. Radiator Corp.

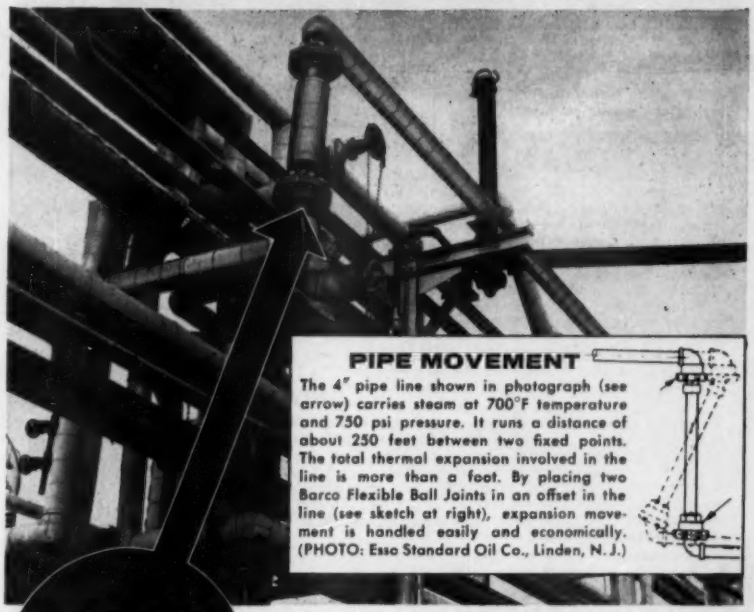
233 Steam Generators — Catalog 56-1 describes a shop-assembled water tube steam generator ready for immediate installation. Dimensional data tables and diagrams included. The Wickes Boiler Co.

234 Self-Contained Boilers — Bulletin AD-162, 8 pp, describes company's complete line of self-contained boilers for heating and processing steam or hot water. Design features and advantages are detailed and a cutaway view showing flow of air in the forced draft system is included. Cleaver-Brooks Co.

235 Integral-Furnace Unit—Bulletin G-94 describes the Type PFI integral-furnace boiler, a pressurized-furnace oil- and gas-fired steam generator for power, process or heating loads requiring steam capacities to 400,000 lb-hr. at pressures to 1150 psi and temperatures to 900 F. Includes information on membrane wall, integral combustion air duct and preassembled boiler components. The Babcock & Wilcox Co.

236 Packaged Steam Generator — This bulletin describes company's type

How Plant Handles 700°F. STEAM . . . PIPE EXPANSION



PIPE MOVEMENT

The 4" pipe line shown in photograph (see arrow) carries steam at 700°F temperature and 750 psi pressure. It runs a distance of about 250 feet between two fixed points. The total thermal expansion involved in the line is more than a foot. By placing two Barco Flexible Ball Joints in an offset in the line (see sketch at right), expansion movement is handled easily and economically. (PHOTO: Esso Standard Oil Co., Linden, N. J.)

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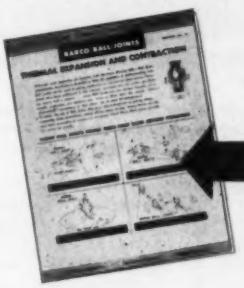

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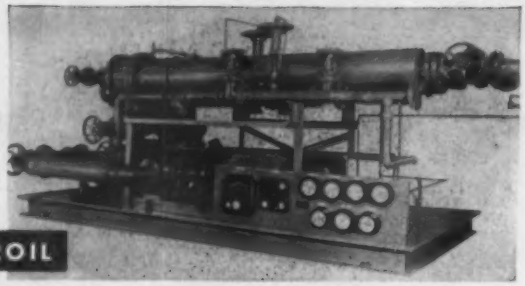

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DK packaged water tube steam generator available in units from 6000 to 60,000 lbs. of steam per hour and design pressures from 200 to 600 psi. Gives features, size and capacity of these boilers. E. Keeler Co.

237 For Low-Pressure Heating — Guide Specifications GS-1, 58 pp, covers underfeed stoker applications to boilers best suited to commercial and industrial heating plants. Includes drawings of flexible layouts of the equipment, as well as specification criteria covering coal and ash handling, boilers, stokers and controls. Bituminous Coal Institute.

FUEL BURNING EQUIPMENT

238 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

239 Automatic Fuel Burner — Eight-pp Reference Bulletin 430B describes features and advantages of company's automatic fuel burner. Design and construction details are illustrated and described. Peabody Engineering Corp.

240 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

241 Oil Burner Parts — Listed in Bulletin 24 are steam, atomizing, large capacity fuel oil burner parts, including burner parts, detaching gears, and valves for burners. Descriptive details provided. National Airoil Burner Co., Inc.

TUBING AND ACCESSORIES

242 Heat Exchanger Tubing — Cited in 30-pp Catalog A-205 are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required such tubing. The International Nickel Co., Inc.

243 Boiler Tube Expanders — Bulletin Y-46, 16 pp, describes three general types of boiler tube expanders and includes detailed specifications to assist in selection. Along with the specification tables, the bulletin includes photos, drawings. Lagonda Div., Elliott Co.

244 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in others. Revere Copper and Brass, Inc.

245 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and plates for condensers and heat exchangers.

Fields of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. The American Brass Co.

247 Electric Tube Cleaners—Bulletin E107 describes advantages and applications of company's electric tube cleaners for boilers, condensers, evaporators, and heat-exchangers. Tables are included giving complete specification details. Elliott Co.-Roto Plant, Div. of Carrier Corp.

REFRACTORIES, INSULATION

248 Refractory Castable — Bulletin R-40 describes the use of Kaocrete, company's refractory castable, in boiler ashpits. A discussion of the various methods of ash removal, along with the maintenance problems peculiar to each, is presented. Four installations detailed. Refractories Div., The Babcock & Wilcox Co.

250 Refractory Mortar — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant, refinery and metalworking equipment. Includes data on mortar preparation, placing procedures, curing; also general instructions, and information on use of Lumnite cement as a masonry mortar for laying brick. Universal Atlas Cement Div., United States Steel Corp.

251 Pipe Insulation — This 40-pp catalog was designed as a reference guide to company's pipe insulation, presenting a new way to specify proper thickness for pipe insulation, based in the "J" factor. This special index eliminates complicated computation formerly required to determine economical thicknesses. The book also features detailed drawings that show how single-layer insulation is applied to various vertical and horizontal expansion joints as well as to pipe bends, flanges, fittings. Union Asbestos & Rubber Co.

COAL AND ASH HANDLING

253 Spreader Stoker—Sixteen-pp Bulletin 800 describes manufacturer's Type C-C RotoStoker, a relatively small spreader stoker offering continuous cleaning and ash discharge advantages of larger units, without need of a basement for ash-removal. Explains this and other operational advantages of the stoker, which is adapted to modern steam boilers with output capacities of about 5000 to 75,000 lbs of steam per hour. Detroit Stoker Co.

255 Coal Crusher — Comapny's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

FANS, VENTILATING

257 Air Engineering — Bulletin E-57 is a 24-pp air engineering data file covering engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handling requirements, entrance and elbow losses are provided. Aerovent Fan Co., Inc.

258 Ventilation Units — Bulletin FM-315, 25 pp, describes basic construction of company's package propeller fans for commercial and industrial applications. Illustrated case histories of typical installations are included, as well as performance data. Buffalo Forge Co.

PUMPS AND COMPRESSORS

259 For CV Pump Sizing — This nomograph is for sizing chemical feeding systems. To use it, you must know the concentration of the chemical solution to be metered, required chemical dosage, and flow rate of process stream. With this information, you can determine necessary pump capacity and tank holding capacity needed according to refilling period. Nomograph also gives sizes of controlled volume pumps that are 20, 50 or 100 per cent over capacity. Milton Roy Co.

260 Proportioning Pumps — Catalog 604, 8 pp, covers details and specifications of two mechanical and hydraulic drive metering and proportioning pumps, for precision pumping as low as 11 cc per min, and a chemical pump for systems requiring limited capacities. Advantages are enumerated and capacities and pressures tabulated. Hills-McCanna Co.

261 For Abusive Pumping Jobs — This Pump Selector covers centrifugal pumps for wide industrial use and especially adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horizontal shaft, single-stage side suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps with standard, overhead and quill bearings for wet pit applications. Nagle Pumps.

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263 Low Pressure Compressors — Eight-pp Bulletin A-95 describes a line of low pressure compressors for heavy duty industrial applications. Engineering design features are detailed and advantages explained. Joy Mfg. Co.

INSTRUMENTS, CONTROLS

265 Instruments and Controls — Catalog 57-6 describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorders, temperature recorder, multipoint gages and others. Includes descriptive data. Republic Flow Meters Co.

267 Bi-Color Gage — Bulletin 2044 describes advantages of the Multi-Port bi-color gage developed to eliminate common gage troubles encountered in low and medium pressure ranges. Design features are illustrated and described and installation methods detailed. Diamond Power Specialty Corp.

268 Resistance Temperature Detectors — In 8-pp Publication 3016D are described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operations, application and construction details of the resistance temperature detectors are presented, along with specifications. Instrument Div., Thomas A. Edison, Inc.

270 Metering, Control Systems — Bulletin 500 describes purpose, design and operation of company's metering and control systems. Includes discussion of pneumatic and electric telemetering and pneumatic control, along with detailed literature references. Bailey Meter Co.

271 Guide to Gages — Catalog 300-B, 112 pp, features Ashcroft Duragauges, Maxisafe, pneumatic receiver, recording, quality, drawn case, chemical and special application gages. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in. Manning, Maxwell & Moore, Inc.

273 For Conductivity Measurement — Electrolytic conductivity equipment for the measurement and control of solution concentration is featured in 30-pp Catalog 23. Complete descriptive information and data on various types of instruments and equipment for different types of applications included. Industrial Instruments Inc.

274 Ring Balance Meters — Specification Sheet PM-10002 features a line of ring balance meters designed to convert fluid differential pressure measurements into flow records and indications. Includes description of operation, specifications. Hagan Chemicals & Controls, Inc.

OTHER EQUIPMENT

276 For Quiet Heating — Described in this bulletin is the HusHeater, designed to heat — without making a sound — water and liquids by introduction of steam into the liquid. Lists advantages of the HusHeater, explains how to install it and tells how to order. Most common application is in filter boxes and hotwells. Sims Pump Valve Co. Inc.

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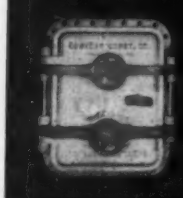

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277 Turbine Lubrication — Basic lubrication requirements for a wide range of turbines and gears are detailed in 28-pp Bulletin T-125-A. Sections cover care of the oiling system, turbine lubricants, lubricating oil recommendations, reduction gears and geared units. Oil circuit diagrams and other illustrations are included. Murray Iron Works Co.

278 Testing Instruments — Bulletin 19–58, 16 pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos of each type. James G. Biddle Co.

279 Sheet Packings — Eight-pp illustrated Bulletin P-328 gives detailed specifications, engineering, application and testing data on industrial sheet packings. Nineteen varieties covered are fabricated from asbestos, rubber, Neoprene, silicone, fiber, Teflon, others. Crane Packing Co.

280 Forged Steel Couplings — Self-aligning forged steel couplings designed to transmit maximum torque are described in illustrated Bulletin 450-M67. A cutaway view shows component features, and tables give ratings and dimensions. Koppers Co., Inc.

281 Refrigeration Condensers— Engineering data on a complete range of sizes and types of refrigeration condensers are featured in 38-pp Bulletin RC-2. Ratings in tons refrigeration are tabulated for large and small ammonia condensers, vertical ammonia condensers, ammonia condenser-towers, freon condensers and freon condenser-towers. Selection data, dimensions given. Henry Vogt Machine Co.

283 Plumbing, Heating Supplies— Edition H is the current edition of this company's 126-pp general catalog on plumbing and heating repair parts, tools and accessories. Indexed and illustrated, the catalog gives information on uses. J. A. Sexauer Mfg. Co., Inc.

284 Steel Plate Construction — Pictured and described in this 20-pp bulletin are some of the steps in the fabrication of steel plate into boiler breechings, casings, duct work, stacks and special shapes, from initial design stage to final erection at plant site. The bulletin is generously illustrated with photos of typical plant installations. Connery Construction Co.

286 Insulated Piping—Bulletin 57-1, 24 pp, on prefabricated insulated piping systems, shows typical uses for Hel-cor pipe units for underground or overhead pipe systems. Also describes Utilidor conduits for protection of underground utility services. Sample specifications and conduit sizing charts given. Ric-wiL, Inc.

287 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

290 Generating Sets — Bulletin 110 contains detailed information on company's generating sets designed for a variety of power generating applications. Capacity and ratings tables are included. Troy Engine & Machine Co.

291 Pneumatic Tools — Featured in Bulletin 67 is a line of pneumatic production equipment, including grinders, sanders, drills, reamers, screwdrivers, nutrunners, filing tools, and cutting tools. Descriptive details and specifications are included. Airetool Mfg Co.

292 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available. Goodall Rubber Co.

293 Wall Deslagger — Bulletin 1034 features company's wall deslagger designed to minimize average slag thickness for consistently high heat-transfer capacity, and for uniform superheat and reheat temperature control. Photos and cutaway view illustrating design, operation included. Copes-Vulcan Div., Blaw-Knox Co.

294 Fuel Oil Conditioner — A fuel oil conditioner which dissolves all sludges, prevents new sludge from forming, excels as an emulsifier of condensation, holds water, sludge and oil in complete suspension and exhibits other performance advantages is described in a recent published pamphlet. Kor Corp, Div. Oxi Corp.

295 Cranes, Hydro Equipment — Twelve-pp Brochure HY-51 describes cranes and equipment for hydroelectric, water supply and other applications. Various components and assemblies that help harness hydroelectric power are pictured, including cranes and hoists, gates and valves, and special hydroelectric equipment. Yuba Consolidated Industries, Inc.

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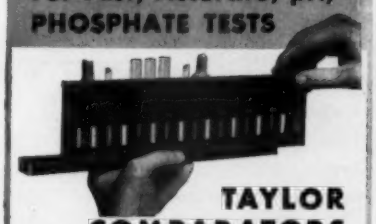

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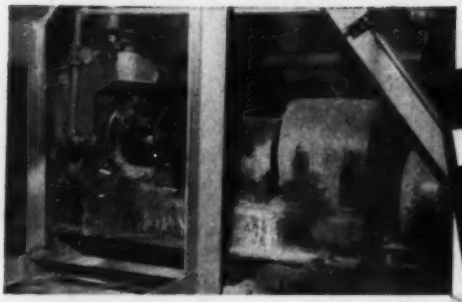

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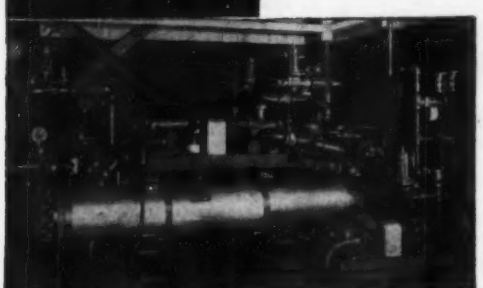

Heaters are insulated and jacketed with removable heads at both ends for cleaning without breaking any piping connections or removing any tube bundles.

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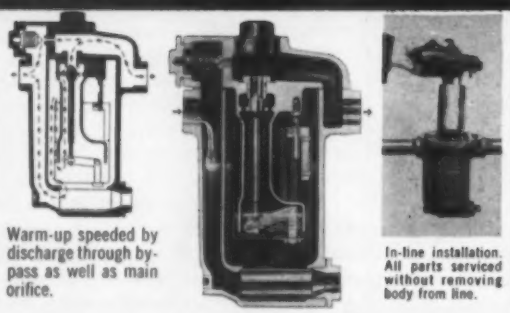

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In-line installation. All parts serviced without removing body from line.

AUTOMATICALLY REGULATES FOR FASTER WARM-UP AND TO KEEP OPERATING TEMPERATURE AT PEAK HEAT

Proven bucket design with built-in accessories. By-pass thermostat increases discharge for warm-up and overload conditions. Thermostat compensated to operate at 10° below saturated steam temp. Wright-Austin Airxpel principle provides for mechanical discharge of air after Thermostatic by-pass has closed.

WRITE FOR BULLETIN 808

WRIGHT-AUSTIN COMPANY
3245 WIGHT STREET • DETROIT 7, MICH.

For more data circle 572 on Post Card

Better Pump Performance With SIMS PUMP VALVES

Because . . .

Stem breakage eliminated — by double shock-absorber stem heads.

Reduced wear — long guides give even lift—springs can't jam.

Smooth seating surface—rotating valve disc changes to new seating surface with every pump stroke.

Increased speed and pump capacity — inclined seat ribs cut flow resistance and reduces turbulence—prevents vapor binding.

Sims Pump Valves, for all reciprocating pumps, are stocked for quick delivery.

Write for Bulletin V-112.

Sims
PUMP VALVE CO., INC.
1314 PARK AVENUE, HOBOKEN, N. J.

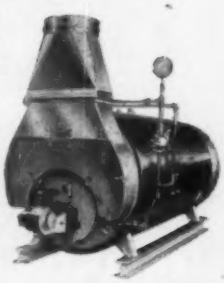
SP111

For more data circle 571 on Post Card

Leffel Boilers Pass The Acid Test:

". . . we have been in the boiler business for nearly fifty years, and the only repair work we have ever done on a Leffel Scotch Marine Boiler has been due to human failing, and not to mechanical failure. The Leffel Scotch Marine Boiler is without a doubt the strongest and most trouble-free boiler built."

Mr. J. J. Bower, President
J. J. Bower Company, Inc.
Roanoke, Va.



No man is in a better position to judge boilers than the man who services and repairs all types and makes. It pays to listen to a man like J. J. Bower for his words are backed by nearly a half-century of experience. In the brief statement above, Mr. Bower cuts away all the claims and promises of most of today's boiler advertising and tells you why *you* should rely on Leffel boilers for your steam requirements.

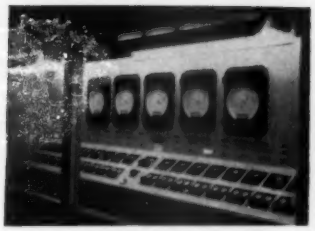
For more details on why you can count on rugged, reliable Leffel boilers for long life and dependable service, write today for your free copy of Bulletin 236.

THE JAMES LEFFEL & COMPANY
Dept. E
SPRINGFIELD, OHIO

For more data circle 573 on Post Card

HAGAN NEWSLETTER

Behind the Panel



THE QUALITY OF MEASUREMENT FIXES THE QUALITY OF CONTROL

Control can only be as precise as the measurements on which it is based. Not only the measurement, but also the means by which it is transmitted to the recording or actuating mechanisms must be as near perfection as possible if a high degree of control quality is to be maintained. Here are some examples of how Hagan achieves exact control by means of accurate measurements:

MEASUREMENT SPAN CRITICAL IN REDUCING TEMPERATURE VARIATIONS

A large eastern steel mill was seeking a temperature controller for continuous strip annealing furnaces—a process that threads light gauge, cold rolled steel through the high temperature furnace in the range of 800 ft/min and provides fully recrystallized steel, ductile in spite of its relative hardness, with other desirable physical properties. They set up a Hagan PowrAmp and a competitive controller side by side on two new furnaces. The suppressed range feature of the PowrAmp made possible the holding of temperature variations to 2-3F—its span was set at 1,500 to 1,700F for the test. On the basis of these very acceptable results, which the competitive controller could not match, the PowrAmp was put in control of the temperature on these two lines. Later, when two more annealing lines were added, PowrAmp temperature controllers were selected—resulting in Hagan control of all four annealing lines at the mill.

SOAKING PIT REAL TEST OF METER TURNDOWN RANGE

When ingots start to heat in a soaking pit, maximum fuel firing is required. But later in the cycle, only enough fuel to maintain the desired temperature is needed. This may be less than 10% of max. Hagan Ring Balance gas and air flow meters, calibrated for a maximum differential of 10"WC, are accurate with as little differential as .035"WC, or about 6% of the full scale of the meter. This means that fuel-air ratios are maintained exactly throughout the full soaking pit cycle. Particularly critical when special alloys are being heated, precision ratio control pays off across the board in maintenance of quality and in fuel savings. (Item C-1)

MEASURING STEAM FLOW WITHOUT A PRIMARY ELEMENT SAVES MONEY

High pressure steam flows may be measured without the use of a primary element in applications where the Reynolds number is in excess of 10,000,000. Since the line loss produced through a certain length of pipe cannot be predicted as accurately as with an orifice plate, it is a necessity that the meter connected to measure the loss have an adjustable range to accommodate the unpredictable differential that can be established only after start up. Due to its wide range of adjustment, the Hagan Ring Balance meter makes feasible the accurate measure of steam flow using pipe friction as the source of differential. This eliminates the need for installing a very expensive, high-alloy flow nozzle in the steam line. (Item C-2)

MUST HAGAN HIGH QUALITY BE HIGH COST?

Public Utilities have learned that this is not the case. The utilities are bound by law to select new equipment on the basis of competitive price and comparable quality. Here is the score for the last 58 new boiler control systems awarded as a result of this competitive bidding:

	Successful Bids		Successful Bids
HAGAN	19	Company "C"	3
Company "A"	19	Company "D"	2
Company "B"	13	Company "E"	2

(Item C-3)

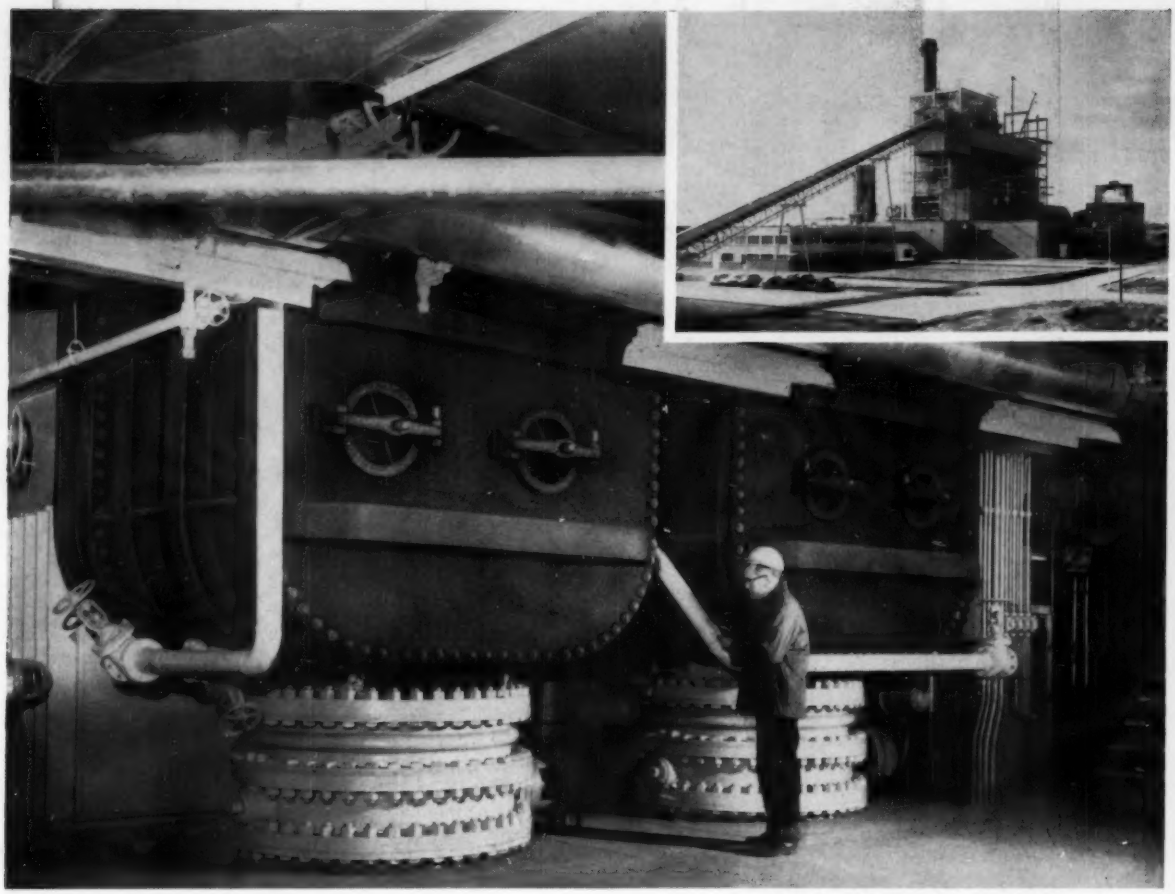
HAGAN CHEMICALS & CONTROLS, INC.

Hagan Building, Room 702, Pittsburgh 30, Pennsylvania
In Canada: Hagan Corporation (Canada) Limited, Toronto
European Division: Via Flumendosa No. 13, Milano, Italy

If you would like more information on any of the above items, check the appropriate box below.

☐ Item C-1 ☐ Item C-2 ☐ Item C-3

For more data circle 574 on Post Card



Consulting Engineers, Ebasco Services, Inc.

YUBA POWER EQUIPMENT MEETS GUARANTEES WITH FLYING COLORS

Based on the performance tests and favorable experience Kansas City Power & Light Company has enjoyed with Yuba power equipment in their Hawthorn Station, a Yuba 70,000 sq. ft. surface condenser and other important heat transfer equipment was specified and recently installed in their new Montrose Station near Clinton, Missouri.

Still another generating unit, planned for completion by this progressive company in mid-1960, will include basic heat transfer equipment supplied by Yuba.

In the operation of Yuba power plant equipment, one fact stands out: guarantees are unfailingly met, providing the economy, efficiency and safety demanded.

Actual performance checks in plant after plant show that performance conditions exceed design specifications. For example, heat transfer coefficient is greater, terminal temperature differential is lower, and oxygen content in the condensate much less than guaranteed.

Your comparison will rate Yuba first too. Let us give you all the facts, today.

Yuba designs and builds a wide range of other equipment for the power industry
Evaporators
Feedwater Heaters
Cranes
Expansion Joints

Write for new Yuba Bulletin No. YHT 100, just off the press. This bulletin describes Yuba Heat Transfer Equipment manufactured for the power industry. Your free copy will be sent without delay.

Power Equipment Engineered and Manufactured by

Yuba Heat Transfer Division • Honesdale, Pa.

Production Facilities in the West

Yuba Manufacturing Division • Benicia, Calif.

YUBA CONSOLIDATED INDUSTRIES, INC.

YUBA

Plants and Sales Offices NATIONWIDE

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